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## *EDITORIAL*

## THE TEMPOROMANDIBULAR JOINT

ABNORMAL conditions of the temporomandibular joints are of great importance to every branch of dentistry and of special interest to the oral surgeon, presenting a challenge to continued clinical investigation and research in order to make possible a critical evaluation of methods of treatment and long-time results.

The bizarre symptomatology of subarthrosis and dysarthrosis of the joints and the frequency of prompt and spectacular relief of discomfort after occlusal splinting and repositioning of the condyle heads are ample evidence that intensive study of the subject is fundamental to dental progress. In particular, in patients with a full complement of natural teeth, the problem of the maintenance of the newly established occlusion and the improvement in position of the condyle head effected by the planned extrusion of posterior teeth requires careful statistical study and reports in order to determine the indications for such treatment rather than conventional opening of the bite by dental restorations. Studies on the effect of such measures on the periodontium and alveolar process, as well as encephalometric studies, are indicated.

The neurologic symptoms accompanying temporomandibular conditions are so varied that the patients may seek the help of the physician, the otolaryngologist or the neurologist. Much has been written on the subject presenting views, experiences and conclusions that have not been based upon a thoroughly comprehensive, scientific study of the problem. Such a study is sorely needed; for it seems highly desirable that the condition of the temporomandibular joints should receive due consideration in all dental restorative diagnosis and treatment planning. This would be a great step



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in dental progress, particularly in the fields of crown and bridge work and in prosthesis.

Consultants who see a considerable number of patients with temporomandibular joint disabilities cannot but be impressed with the possibilities of early preventive treatment by means of restorative dental procedures that are planned to reposition the displaced condyle heads. The same is true in the field of full denture service, and the condition of the joints should be ascertained in order to provide an effective occlusion and one that will also prevent potential joint involvement and check or at least relieve an already existing joint disability.

All too frequently, the lack of knowledge regarding the symptomatology of joint conditions leads to the extraction of molar teeth suspected as the cause of discomfort or pain, and the patient is immediately placed in a situation where effective repositioning of the displaced condyle heads by dental restoration is difficult or impossible.

The roentgenographic diagnosis of abnormalities of the temporomandibular joints is complicated by the difficulty of securing uniformly good views of the joint structures. Several projection technics are used with varying success in the matter of affording good interpretation. An exact technic should make possible a subsequent examination with projection and positioning identical, or so nearly so that an accurate evaluation of the results of treatment is possible. It seems very likely that an exhaustive study of the possibilities of stereoscopic roentgenography of the joints would be of great future service in diagnosis and treatment. It is worthy of thorough investigation for service in the more difficult type of cases.

Congenital deformities and infections of or injury of the temporomandibular joints occurring in infancy often result in serious failure of development of the ramus of the mandible on the affected side, with gross external and occlusal deformities. The infrequency of such conditions makes it imperative that contemporary correlated research into all aspects of treatment be undertaken by oral surgeons and orthodontists in numerous large centers.

Fractures of the condyle should be made the subject of similar correlative clinical research. Few critical follow-up reports of the results of treatment extending over a number of years are available, but such reports are indicated to clarify differences of opinion regarding methods of treatment. Dr. Kurt H. Thoma presents his experiences in the open reduction of this type of fracture in this issue.

The editors of the JOURNAL OF ORAL SURGERY plan to encourage and assist in every possible manner clinical oral surgical research in this and in numerous other problems incident to surgery of the mouth.

C. W. WALDRON.

# FRACTURES AND FRACTURE DISLOCATIONS OF THE MANDIBULAR CONDYLE: A METHOD FOR OPEN REDUCTION AND INTERNAL WIRING AND ONE FOR SKELETAL FIXATION, WITH A REPORT OF THIRTY-TWO CASES*

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DURING the past twenty months, I have treated thirty-two condylar and subcondylar fractures of the mandible. Although I have been interested in these fractures for a long time, my previous papers on the subject (1938)[1] dealt principally with classification and recognition of complications. In this paper, methods of treatment will receive greater attention. For the past two years, I have tried to improve on the methods currently used for the treatment of these injuries, and I present in this paper the development of an operative procedure by which, in complicated cases, better results can be expected than with the methods used in the past.

## HISTORICAL REVIEW

One of the oldest documents dealing with condylar fractures is that of Desault,[2] published in 1805. He recognized the importance of restoring contact with the fragments and stated that union might fail to take place if the slightest movement of the jaw occurred. If there was no contact, the callus produced might render the condyle irregular and deformed, which, he stated, was apt to impede function of the jaw.

Boyer (1805),[3] in his "Lectures on Diseases of Bones," emphasized the importance of retaining condylar fragments in position, but he stated that this was sometimes impossible. He cited a case in which a condyle had to be removed eight months after the accident because a fistula formed in the external auditory canal. Malgaigne (1847)[4] cited Ribes, who had observed two patients with fractures through the neck of the condyle in which lateral distortion of the jaw resulted in spite of the most ardent and skilful attention. Desault[2] tried to reduce condylar fractures by external manipulation of the jaw and the placing of a thick compress behind it "to fill the hollow under the ear" and to retain the advanced body of the bone in line with the displaced condyle. Ribes believed it was possible to effect positioning of the condylar fragment by carrying the index finger of the right hand to the lateral and inferior part of the pharynx. Following the

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posterior border of the ramus, he was able to feel the inner side of the condyle so that it could be pushed outward and engaged upon the other fragment when the body of the mandible was pushed up and back. In this way, he was, he believed, able to fix the condyle between the body of the mandible and the glenoid cavity, "holding it by a sling." Obviously, this method can be used only for condyles displaced medially and fractured far down on the ramus, if it can be used at all.

During the past few decades, condylar fractures have become a great problem. The popularity of sports and the more general use of the automobile and airplane for transportation have increased the incidence of jaw fractures. The introduction of the x-rays for examination of fractured bones has been an aid to recognition of condylar fractures, but, because the condyle in a lateral view is so frequently covered by the shadow of the

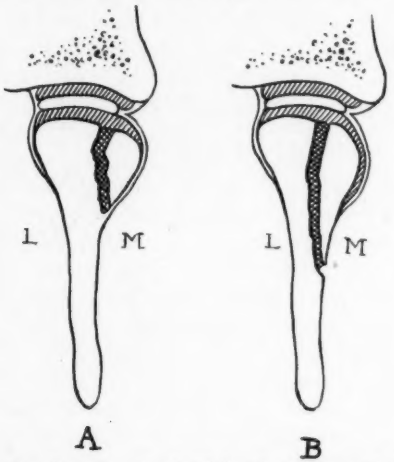


Fig. 1.—Intracapsular fractures, *A*, involving head of condyle only; *B*, involving head and neck of condyle.

cervical vertebrae, these fractures were frequently overlooked in the past. An improved x-ray technic and the use of exposures from an anteroposterior position made more accurate diagnosis possible, and led to a better classification of these injuries.

## CLASSIFICATION

Rüedi (1928)[5] and Dufourmental (1929)[6] made the first comprehensive studies of condylar fractures, and, in 1938, I suggested a classification which has since been amplified. The following fractures may be distinguished:

A. Condylar fractures

1. Without displacement of the condyle

(a) Greenstick
(b) Intracapsular
(c) Extracapsular

2. With displacement of the condyle
   (a) Lateral
   (b) Medial
   (c) Forward
   (d) Backward
3. With overriding of the fragments
4. With dislocation in lateral and medial directions
   (a) Intracapsular (subluxation)
   (b) Complete fracture dislocation (40-90 degrees)
   (c) Complete dislodgment of the condyle.
   (d) Dislocation of the fractured part of the head of the condyle

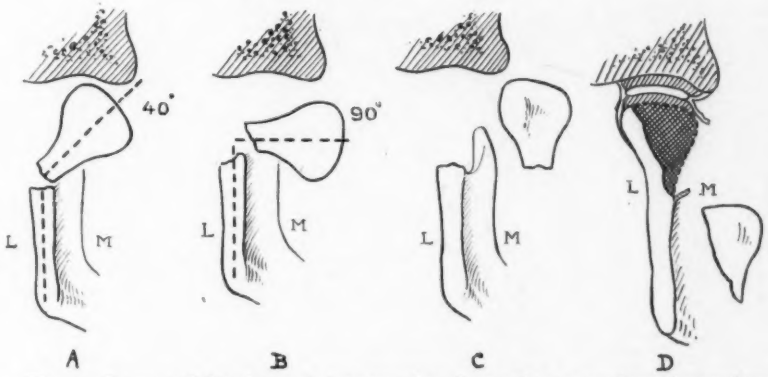


Fig. 2.—Fracture dislocations: *A*, intracapsular; *B*, complete separation; *C*, complete dislodgment; *D*, dislocation of part of head of condyle.

5. With dislocation in a forward direction
   (a) Posteriorly from the articular eminence
   (b) Anteriorly from the articular eminence
6. With dislocation and displacement of the meniscus
7. With comminution
8. Old, with deformities
   (a) Pseudoarthrosis
   (b) Ankylosis

B. Subcondylar fractures
   1. Without displacement of the fragments
   2. With displacement of the fragments

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DESCRIPTION OF THE VARIOUS TYPES

A. *Condylar Fractures.*—Condylar fractures may extend through the head, neck or base of the condyle.

1. Fractures Without Displacement: These may be greenstick fractures or complete fractures in which the fragments remain in their anatomic positions. (Fig. 10.) They occur generally through the surgical neck and therefore are extracapsular, but occasionally they divide the condylar head in a sagittal plane, involving the articular surface, when they are intracapsular fractures. Vertical fractures may extend through the head, neck and ramus of the jaw. (Fig. 1.) Fractures without displacement can be conservatively treated. Generally, intermaxillary fixation is sufficient.

2. Fractures with Displacement of the Condyle: The small condylar fragment is displaced laterally, as seen in Figure 22, or medially, as in

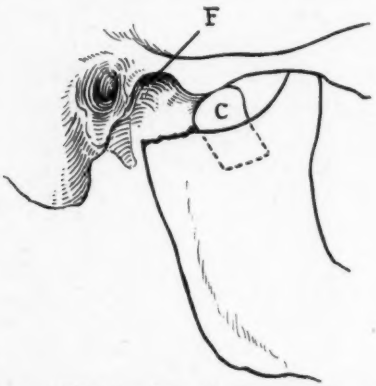



Fig. 3.—Fracture dislocation forward: *F*, glenoid fossa; *C*, condyle.

Figure 17. In either instance, we may find also a forward displacement (Fig. 46), because the external pterygoid muscle generally attached to the condylar fragment exerts force in a forward direction. Backward displacement of the condyle, which is rare, is caused by impaction of the condyle by the ramus. (Fig. 36.)

3. Fractures with Overriding of the Fragments: Overriding of the fragments, which is very common in all types of displacement of the condyle (Fig. 8), is caused by the action of the elevator muscles in pulling the ramus toward the base of the skull.

Open reduction with internal wiring fixation is recommended for cases of types 2 and 3, particularly if the displacement causes occlusal disturbances.

4. Fracture Dislocation Medially or Laterally: Because of anatomic con-

ditions, medial dislocation is most frequent. Lateral dislocation is extremely rare since the temporomandibular ligament reinforces the external part of the capsule. Forward dislocation also occurs but rarely, and is not easily recognized.

(a) Intracapsular fracture dislocations (subluxation). In medial or lateral dislocation, the head of the condyle is displaced up to 40 degrees, as seen in an anteroposterior x-ray view. (Fig. 11.) The capsule is not torn and the condition is really a subluxation only and occurs in a modified form in virtually all fractures with marked medial or lateral displacement. (Fig. 24.) The fragment at the fracture site may be in contact, and in children it may be of the greenstick type. In other cases, the fragments may be distracted,

Fig. 4. (Case 1).—Lateral view of subcondylar fracture.

especially when the mandible is positioned in occlusion. While the first may be conservatively treated, the latter requires open reduction.

(b) Complete fracture dislocations. In complete dislocation, the capsule is torn and the condyle is partly or completely out of the glenoid fossa. (Fig. 2*B*.) In medial dislocation, the empty joint cavity can be felt by the palpating finger, unless the ramus is pulled up into it. In such cases, the sharp end of the ramus may also pierce the external auditory canal and cause bleeding from the ear, which should be differentiated from bleeding due to fracture of the base of the skull. In lateral dislocation, which is rare, the presence of the head of the condyle produces a marked palpable swell-

ing under the skin in front of the ear. The anteroposterior x-ray view shows the condyle displaced 40-90 degrees. The fractured ends may be in contact or may be so displaced that, when the teeth are put in occlusion, the ends are far apart. The condyle may project across the fractured surface of the ramus, in which case the fractured end extends laterally and can be felt. (Fig. 28.)

(c) Fracture dislocation with complete dislodgment of the condyle. In these cases, the condyle is pulled forward and inward, and may be found below the mandibular notch. (Fig. 2*C*.) Since the external pterygoid muscle generally remains attached, the condylar fragment stays viable. Part of its blood supply is derived from the branches of the deep auricular artery,

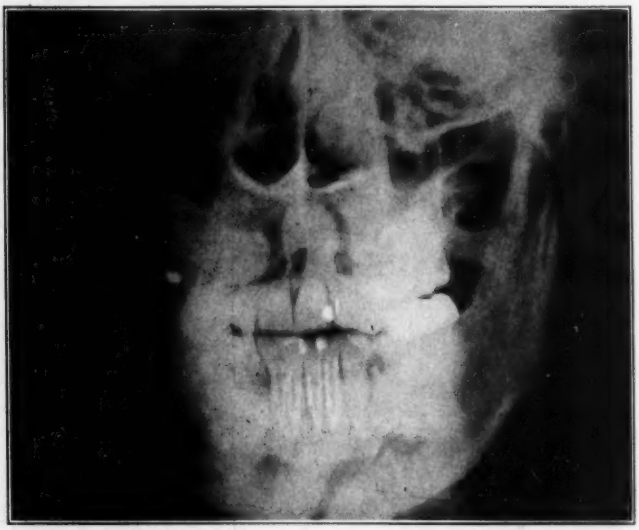


Fig. 5 (Case 1).—Anteroposterior view of subcondylar fracture.

which passes through this muscle, entering the condyle through small foramina. Even when it is detached from the muscle and lying apart in the tissue, an attempt to save it may be successful, because, in this situation, it is similar to a bone transplant, and the fact that the condyle fits exactly and has an articular surface covered by cartilage is an advantage over the transplant. Open reduction is required to restore anatomic conditions.

(d) Dislocation of part of the head of the condyle. The medial portion of the condyle may be fractured off and dislocated. Such fractures occur in a sagittal plane, and the detached part is usually displaced. Not being attached to the pterygoid muscle, it may wander a considerable distance,

and may be found somewhere in the pterygoid fossa. If the mandibular fragment retains some of the articulating surface, the fractured part of the condyle may be ignored, and conservative and often functional treatment can be instituted. In oblique fractures with virtually the entire articulating surface dislodged (Fig. 2*D*), open reduction is required (Case 12).

5. Fracture Dislocation in Forward Direction: This type of dislocation is generally intracapsular. The capsule is not torn, but may be stretched considerably, as a consequence of which the patient may experience repeated dislocation of the jaw later.

(a) In some cases, the condyle may be found posteriorly from the eminentia articularis, as in Figure 3, and the fracture may be treated conservatively, especially in young individuals (Case 6).

(b) In other cases, the condyle may be locked in front of the eminentia

Fig. 6.—Inner aspect of mandibular ramus showing sphenomandibular and stylomandibular ligaments.

articularis, and replacement into position by surgical approach is advisable.

6. Fracture Dislocations with Displacement of the Meniscus: In all cases of subluxation and dislocation, the meniscus may become displaced or even torn, and may cause obstruction, so that the condyle cannot be properly reduced. In greenstick fracture with dislocation, this may prevent the patient from closing the jaw, as in Case 4.

7. Comminuted Condylar Fractures: These fractures are rare in civilian injuries. Birth trauma has been reported as the cause of injury of this type, resulting in ankylosis. Occasionally, they occur in adults from gunshot wounds. A case of comminuted fracture in a woman who attempted suicide with a .32 caliber revolver was reported by Armbrecht and Shilling (1942).[7]

In most instances, the fragments of bone should be removed surgically.

8. Old Condylar Fractures with Deformity: Minor deformities, as stated, are not uncommon, but the more serious types requiring surgical interference are listed here.

(a) Pseudarthrosis. Untreated condylar fractures or fractures mobilized too soon, or ineffectively treated, may develop a pseudarthrosis in the fracture line. A case of this type included in this series was completely reported previously (1943).[8]

(b) Ankylosis. Fibrous and bony ankylosis occur from birth trauma if the mandibular joint is injured by forceps delivery of a large baby. A patient sustaining such an injury is included in the accompanying table, the case being reported previously (1944).[9] Ankylosis may also follow intracapsular fracture, developing from hemorrhage into the joint or from prolonged immobilization. A patient 30 years of age who had been treated else-

Fig. 7 (Case 2).—Plaster cap with extension rods, one holding condyle in glenoid fossa; the other used for applying elastic traction on pins inserted in chin.

where seven years ago, with intermaxillary traction for six weeks, presented complete ankylosis.

*B. Subcondylar Fractures.*—These are actually fractures of the ascending ramus, generally transverse, as shown in Figure 4. It is important to differentiate between condylar and subcondylar fracture because fracture through the head or the surgical neck of the condyle can be reduced by internal wiring through an incision above the facial nerve, as will be described later. If operative procedure is indicated, subcondylar fractures may be approached only by an incision below the angle of the jaw, and therefore below the facial nerve. Such an approach has been described by Dingman (1944)[10] for wiring in osteotomy through the ramus of the jaw.

In subcondylar fracture, the bone usually is not grossly displaced, because the fracture extends into the region of muscle insertion and, because of muscle spasm associated with the injury, tends to reduce itself. When there is forward and lateral displacement, often with tissue wedged between the fragments, open reduction alone will restore anatomic conditions. However, such fractures may heal and, even with considerable displacement, the resulting deformity does not cause serious disturbance. An example is given in Case 1. Healing in a displaced position is not so serious as in condylar fractures, because angulation, owing to the length of the fragment, is never very great. Therefore, the intracapsular luxation produced by

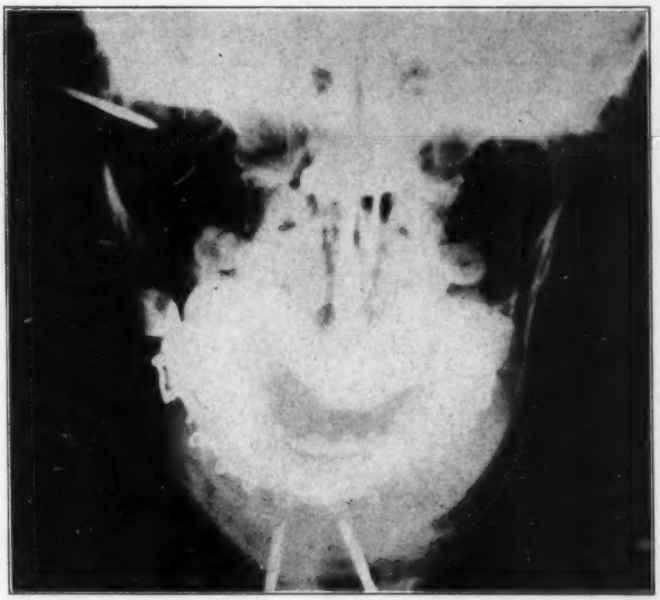


Fig. 8 (Case 2).—Condylar fracture with medial displacement in child aged 12; showing pin in condyle and two pins in anterior part of mandible, and Jelenko splints.

this displacement, which is generally the cause for joint discomfort after healing, is minimal.

## REPORT OF CASES

CASE I.—*Oblique Subcondylar Fracture with Lateral and Forward Displacement.*—D. B. (42988), a man, aged 41, four weeks before he presented himself for treatment was thrown from a wagon and struck by an automobile, being rendered unconscious for from twelve to sixteen hours. He had a broken leg and bruises, for which he had received treatment at another hospital.

There was a swelling on the left side of the jaw, with a fistula discharging pus. X-ray examination revealed two mandibular fractures; one on the left in the horizontal ramus with fragments separated; the other on the right, a subcondylar fracture extending obliquely from the base of the coronoid process almost to the angle of the jaw. Besides the forward displacement shown in Figure 4, there was lateral displacement of the condylar fragment. (Fig. 5.)

The fracture was reduced under endotracheal ether anesthesia by means of three half pins, one inserted in the condylar fragment, the other two at the inferior border of the mandible. Because the fracture was 4 weeks old, the displacement could be only moderately improved. Fixation was accomplished by applying connecting bars forming a triangle to obtain rigidity. Intermaxillary fixation was used to take care of the mandibular fracture on the left.

The postoperative course was uneventful and, after four weeks, when the

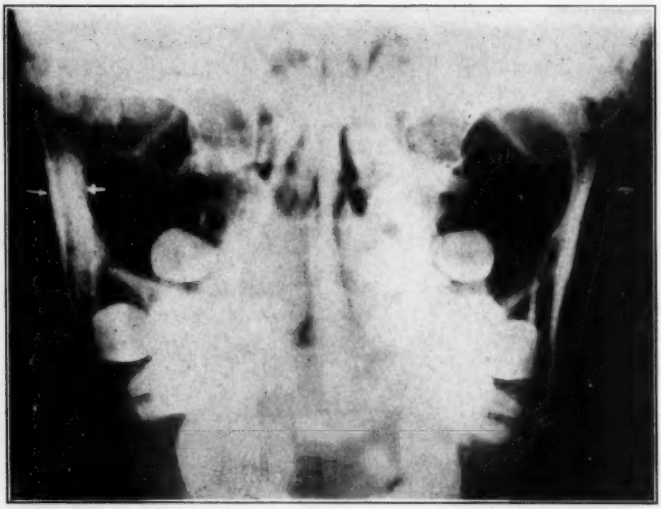


**Fig. 9 (Case 2).—Roentgenogram taken two months after treatment; showing good union, but thickening and shortening of condyle. In children, epiphyseal growth will bring about normal conditions spontaneously.**

jaw was mobilized, the patient was found to have good union of the subcondylar fracture with considerable callus along the fracture of the left mandible. One week later, he was comfortable and had adequate function of the jaw and satisfactory occlusion of the teeth.

### DIFFERENTIAL DIAGNOSIS

Unilateral and bilateral condylar fracture or fracture dislocation occurs with or without other fracture of the mandible. In unilateral fracture, which is generally due to indirect force, the mandibular fracture, as a rule,

is on the opposite side. In this case, the neck of the condyle is almost always medially displaced. In fracture caused by direct force, such as a blow to the side of the jaw, both condylar and mandibular fractures are on the same side, and the displacement of the condylar neck is usually of the lateral type.

The various complications shown in the classification occur frequently. Bellinger, Henny and Peterson (1943),[11] in an analysis of 100 cases, found overriding with no displacement in 16 per cent, displacement in 57 per cent, dislocation in 25 per cent and fracture involving the joint surface (intracapsular) in 2 per cent. Walker (1942)[12] added gunshot fracture of this classification. These fractures generally cause comminution of the condyle and glenoid cavity, as pointed out above.

The condylar fractures treated at my clinic at the Massachusetts General

ANALYSIS OF THIRTY-TWO CASES OF CONDYLAR FRACTURE

| | | | |
|---|---|---|---|
| Number of fractures | 32 | Number of patients | 27 |
| Condylar | 27 | Male | 19 |
| Subcondylar | 5 | Female | 8 |
| Right condyle | 20 | Fractures | |
| Left condyle | 12 | Unilateral | 22 |
| No displacement of condyle | 3 | Bilateral | 5 |
| Displacement laterally | 7 | No other mandibular fracture | 11 |
| Displacement medially | 4 | One other mandibular fracture | 11 |
| Fracture dislocation, medially | 10 | Two other mandibular fractures | 2 |
| Subluxation | 4 | Comminuted mandibular fracture | 3 |
| Complete dislocation | 3 | Treated by intermaxillary fixation | 24 |
| Complete dislodgment | 2 | With open reduction without local fixation | 1 |
| Dislocation of part of condyle | 1 | With internal wiring fixation | 7 |
| Fracture dislocation forward | 1 | With skeletal fixation | 5 |
| Fracture dislocation with displaced meniscus | 1 | With internal wiring and skeletal fixation | 1 |
| Old fracture with pseudarthrosis | 1 | Condylectomy | 1 |
| With ankylosis | 2 | Osteoarthrotomy | 3 |

Hospital and in private practice during the past twenty months are analyzed in the accompanying table.

## REVIEW OF METHODS ADVOCATED FOR TREATMENT

*Treatment.*—In treating condylar fracture, the main effort of most of those who have written on this subject in the past has been directed toward attainment of intermaxillary fixation with the teeth in normal occlusion to correct open-bite and lateral deviation of the jaw. Little has been done to correct overriding, displacement and dislocation of the condyle, which are the main underlying causes of ensuing functional debility of the mandibular joint. The following methods have been advocated:

Immobilization by Intermaxillary Ligation: This treatment has been advocated by Cole and Bubb (1916),[13] Boon (1926),[14] Aufderheide (1934),[15] Ivy and Curtis (1928),[16] James (1940),[17] Mead (1940),[18]

Fig. 10 (Case 3).—Condylar fracture without displacement.

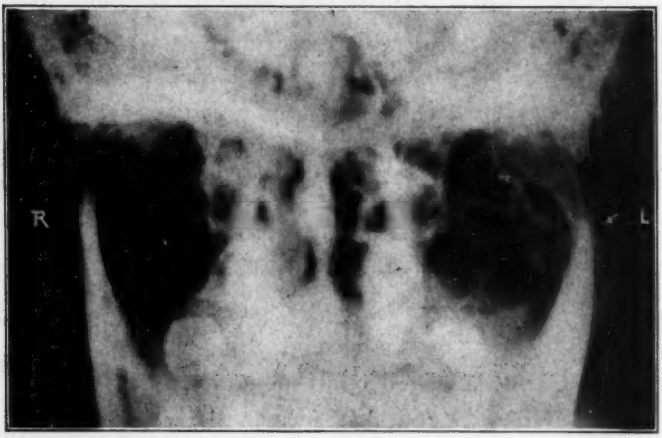



Fig. 11 (Case 4).—Intracapsular fracture dislocation with no displacement of fragments.

Winter (1943)[19] and Berger (1943).[20] Bonny (1927)[21] used intermaxillary wiring in a case associated with open-bite, tightening the wires every day until normal occlusion was obtained. Cole and Bubb (1916)[13] and Russell (1930)[22] recommended splints to keep the mouth in open-bite position. Walker (1942)[12] pointed out the fact that this tended to result in malocclusion. Krohn (1934)[23] has recommended the use of intra-oral splints

with extra-oral extension for the application of rubber-band traction from a plaster-of-Paris cap applied to the head in order to correct open-bite.

In fracture dislocations, Waldron (1942)[24] believed that intermaxillary ligation also gave satisfactory results. Rüedi (1928),[5] in cases seen at the Zurich University Clinic, did not find any serious disturbance after conservative treatment of fracture dislocation. Therefore, he advised leaving the condyle in a dislocated position. Steinhardt (1936)[25] believed that, in

Fig. 12 (Case 5).—Intermaxillary elastic traction in Stout's method of continuous wiring, with posterior biteblocks used in case of boy aged 17 with bilateral condylar fractures.

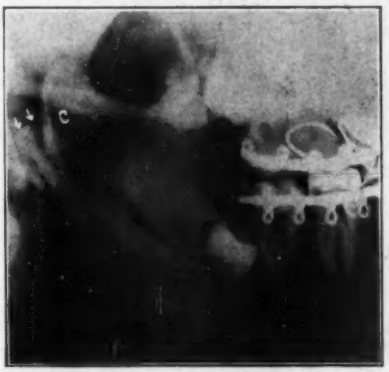


Fig. 13 (Case 6).—Patient, aged 16, with fracture dislocation. The condyle is displaced forward.

such cases, as a result of function, the dislocated condyle would be rebuilt and form a new, well-functioning joint. Perthes (1924)[26] and Wassmund (1934)[27] found the occlusion to be unsatisfactory, with a tendency to open-bite, and mastication and the lateral excursions of the mandible hindered. They described a peculiar appearance of the face when the patient masticated food, pointing out that, in many cases, the fragments

may be so displaced that union is impossible. Both writers advised surgical interference for good, anatomic results. In some instances, the functional result from conservative treatment is so poor that Perthes recommends an osteotomy of the ramus to correct this deformity.

In children, the successful treatment of fracture of the condyle by the conservative wiring method has been reported by Brown and Hamm (1932)[28] and Thoma (1938).[1] These are frequently of the greenstick type, but may be complicated by dislocation. Operations on a child's condyle may interfere with the epiphyseal growth of the jaw, and therefore should be avoided. I have found that, in children, a good final result may be spontaneous, after a year or two, if the fracture, treated conservatively, heals in malposition.

Functional Treatment: To allow active movement of the jaw was advocated by Zemsky (1926),[29] Guy (1928)[30] and Steadman (1939).[31] All

Fig. 14 (Case 6).—Roentgenogram taken eighteen months later (compare Figure 13), showing fracture healed, condyle placed anteriorly and somewhat deformed and mandible slightly displaced distally.

believed that immobilization was unnecessary, and inadvisable, often resulting in incomplete function. Dufourmental (1929)[6] recommended the use of arch wires and elastic traction to control the movement. Walker,[12] on the other hand, stated that active movement or movement controlled by elastics led to the formation of a false joint. I agreed with him and I presented a patient (1943),[8] 18 years old, who had had a fracture of the jaw at the age of 9 years. Inadequate treatment had led to pseudarthrosis, with pain and limited motion.

A combination of fixation and functional treatment is recommended by Fry (1929)[32] and others, who believe in fixation for a short period only, from two to three weeks, to be followed by active movement. Reichenbach

(1934)[33] prefers immobilization followed by orthopedic measures, especially in fracture dislocation, to improve function of the jaw.

*Opinions Reported on the Results of the Methods Described.*—The opinion has been almost universally expressed that condylar fractures take

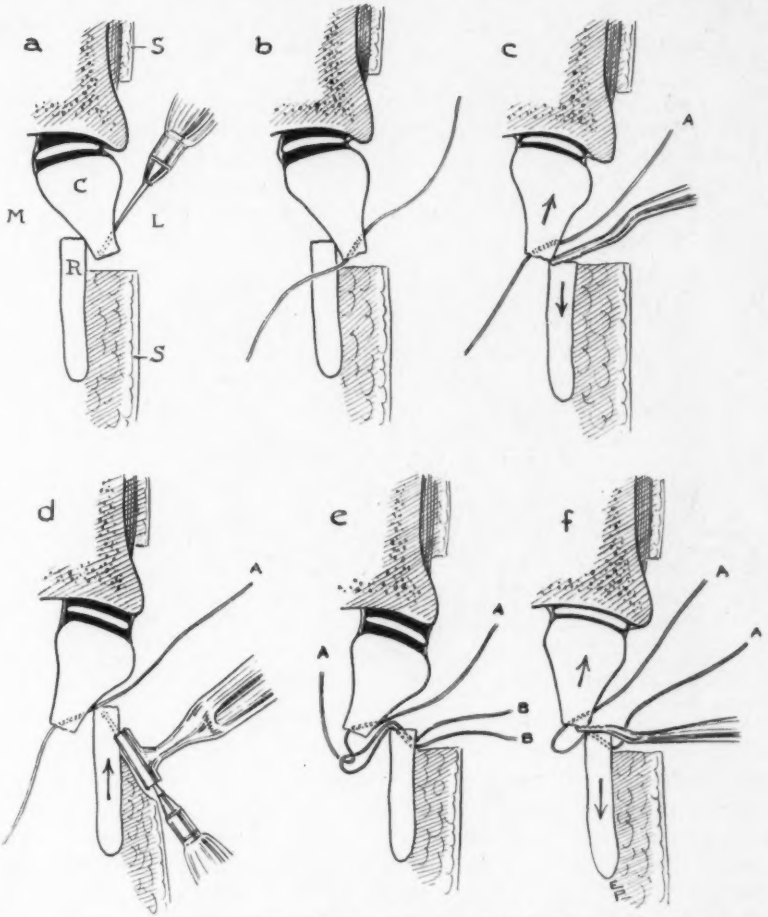



Fig. 15.—Internal wiring fixation of fractured condyle with lateral overriding.

care of themselves if intermaxillary ligation is applied. Kazanjian and Strock (1932)[34] went as far as to say: "Much harm can be done by failing to recognize the fact that condyle fractures do well if no radical procedures

are attempted and the operator contents himself with simple immobilization."

Careful checking of the ultimate results does not give so good a picture, and the very fact that so many different kinds of treatment have been advo-

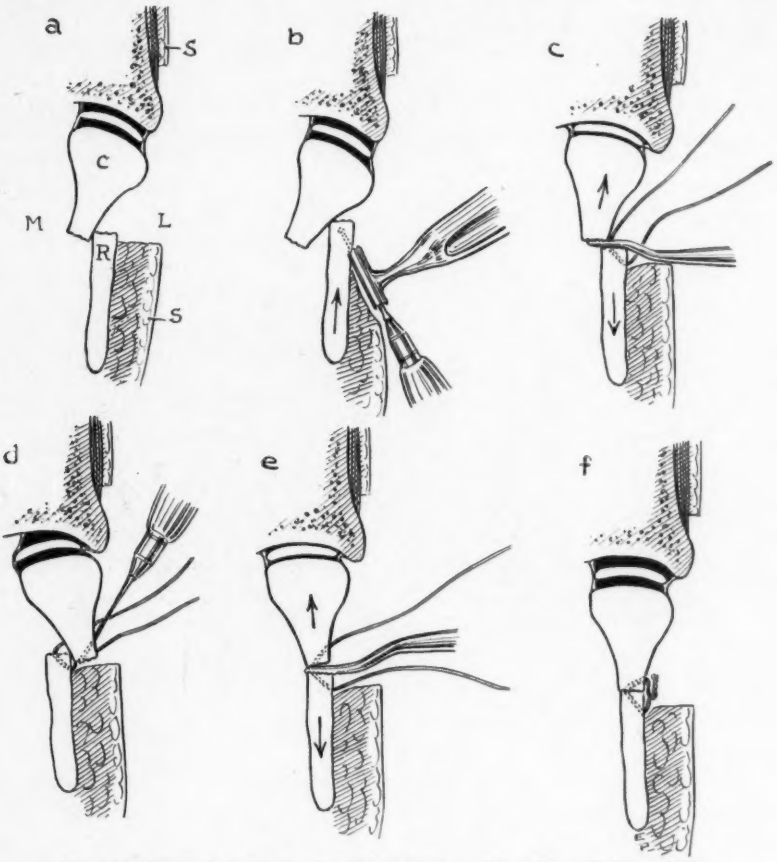



Fig. 16.—Internal wiring fixation of fractured condyle with medial overriding.

cated denotes dissatisfaction. Campbell (1932)[35] reported restricted motion of the mandible following conservative treatment of such fractures. Risdon (1934)[36] reported ankylosis in 5 per cent of the treated cases. Federspiel (1939)[37] stated that he never had a case of dislocated and fractured condyle in which it was possible to avoid limitation of motion. Gruber and Lyford (1942)[38] examined ten patients, all of whom had been treated by inter-

maxillary fixation for six weeks, and found that five had minimal loss of function; three had appreciable loss of function, malocclusion and deviation of the mandible, and two suffered ankylosis requiring arthroplastic procedures. I have seen one patient with pseudarthrosis and two with ankylosis in addition to a number of patients who presented minor complaints or slight occlusal abnormalities (Case 6).

The realization, through careful checking, that the results of treatment with intermaxillary ligation were not so good as reports of individual cases led one to believe resulted in attempts to improve the technic both of reduction and of fixation of fractures of the condyle. Since more than average skill and experience are needed to practice open reduction, almost every one has been trying to develop a conservative method that would give satisfactory results in the hands of the average practitioner.

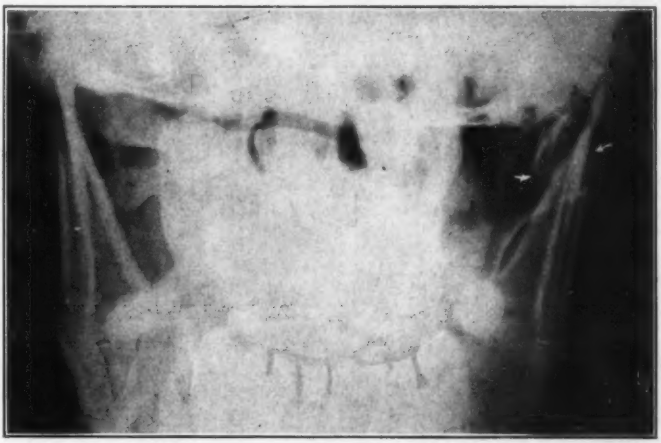


Fig. 17 (Case 7).—Condylar fracture with medial overriding of condyle. The arrows point to fracture surfaces.

*Experiments with Leverage and Traction.*—In order to correct shortening of the ramus caused by overriding, Ivy and Curtis (1928)[16] suggested interposing a baseplate guttapercha wedge between the molar teeth before fastening the teeth in occlusion. Waldron (1942)[24] recommended placing a split piece of rubber tubing between the upper and lower molars, with intermaxillary elastics applied to the teeth. Gruber and Lyford (1942)[38] advised that increasingly larger wooden wedges be inserted between the posterior teeth to overcome the muscle spasm causing the overriding. For patients with edentulous or partly edentulous jaws in which these procedures could not be applied, they advocated an appliance making it possible to

increase the distance between edentulous posterior sections by turning a jackscrew that would push down the mandibular fragment.

I have (1944),[39] for some time, tried biteblocks with elastic traction by means of Stout wiring or the use of Jelenko splints attached to the upper and lower teeth. Traction was applied particularly in the incisor region in order to get as good a lever action as possible. This method, in favorable cases, has resulted in satisfactory occlusion, but has not been universally acceptable. It did not correct the overriding at the neck of the condyle, and, of course, did not reduce fracture dislocations.

Krohn's (1934)[23] use of intra-oral splints with extra-oral traction to correct open-bite led me to experiment with thicker biteblocks (1944)[40] and external traction by means of strong elastic bands attached, in one case, to a "Frac-Sure" appliance that had been employed for fixation of a fracture at the symphysis, and in another case to two half pins inserted in the chin. The other end of the elastic was attached to an extension rod from

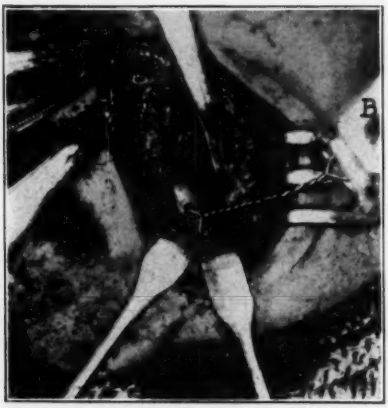



Fig. 18 (Case 7).—Wire inserted and twisted with wire twister, *B*.

a Woodard headband or a plaster cap (1942).[41] This procedure was not successful, and I decided that some periosteal or capsular attachment between the fragments was probably pulling the condyle down, since the ability of the condyle to undergo wide excursions within the capsular ligaments is well known. In two cases, I inserted in the neck of the condyle a half pin, by which I pulled the condyle into the glenoid fossa by direct force or by traction while pulling the ramus down by traction applied from the headband to the chin, as described, with biteblocks between the posterior teeth (Case 2). This attempt also was unsuccessful in preventing overriding. The reason for failure of this method may be understood if the articulation of the mandible is carefully considered. It is not muscular

Fig. 19 (Case 7).—Wire made taut and cut; fracture reduced.

Fig. 20 (Case 7).—Incision closed with interrupted sutures; rubber dam placed to prevent formation of hematoma.

spasm alone that resists the downward pull of the ramus of the jaw: the resistance is mainly due to the action of the accessory ligaments, as shown in Figure 6, which hold it in suspension and resist efforts to distract the fragments, in order to impact them properly.

CASE 2.—*Fracture of Condyle with Medial Displacement and Overriding Treated by Traction.*—H. C. (421493), a girl aged 12 years, had been in an automobile accident three weeks before, her face being struck against the

instrument panel. The upper anterior teeth were knocked out and considerable pain was experienced in the jaw. The treatment received at two other institutions was unsuccessful. Because of loss of the anterior teeth, the marked open-bite could not be corrected satisfactorily. The patient experienced pain while chewing.

X-rays revealed a fracture of the mandible in the left cuspid region and a fracture through the neck of the right condyle, with medial displacement and overriding.

Under endotracheal ether anesthesia, a half pin was inserted through the skin in front of the tragus into the condylar fragment, and two pins were inserted in the mental prominence of the mandible. The pin in the condyle was attached to a wire extending from the side of a plaster cap by means of parts from a "Frac-Sure" appliance, thus pulling the condyle into the glenoid

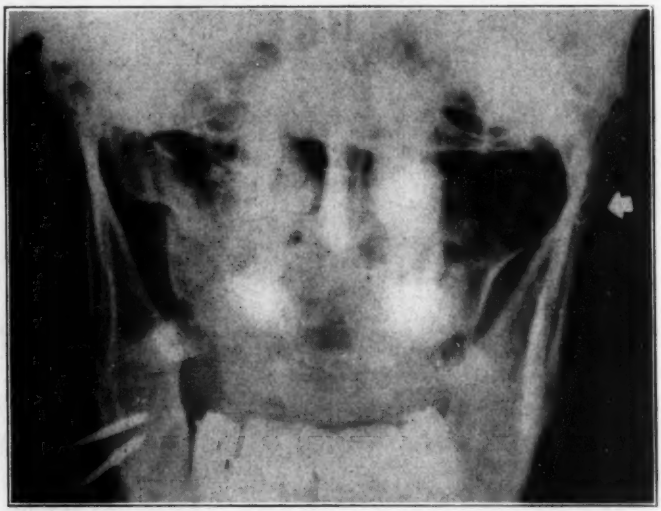


**Fig. 21 (Case 7).—Postoperative roentgenogram showing internal wiring fixation and skeletal fixation for fracture of mandible on other side.**

fossa. In addition, Jelenko splints were attached to the upper and lower teeth for intra-oral elastic traction, with large wedges placed between the molars. Traction was also applied from the head cap to a "Frac-Sure" cross bar attached to the pins in the anterior part of the mandible. (Fig. 7.) In spite of this tremendous amount of force, applied for fourteen days, the overriding was not overcome. A very good functional result was obtained. The neck of the condyle had been brought into contact with the medial aspect of the ramus (Fig. 8), and union occurred. The only visible defect seen in the x-ray film was a thickening of the condylar neck. (Fig. 9.) Nine weeks after treatment had begun, function of the jaw was found to be excellent, as could

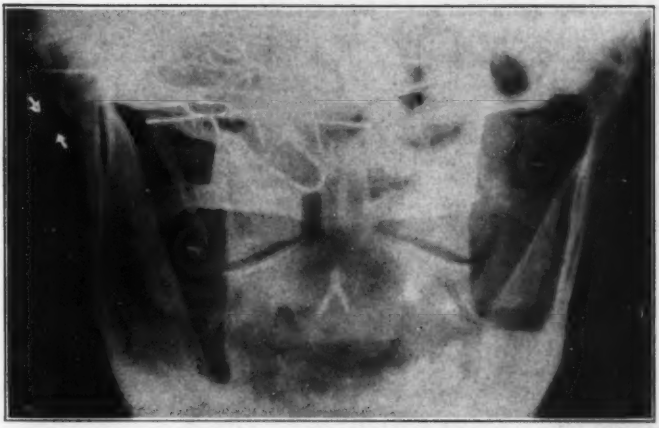


Fig. 22 (Case 8).—Roentgenogram showing condylar fracture with lateral displacement. Arrows point to fracture surface of the condyle removed from the fracture surface of the ramus.

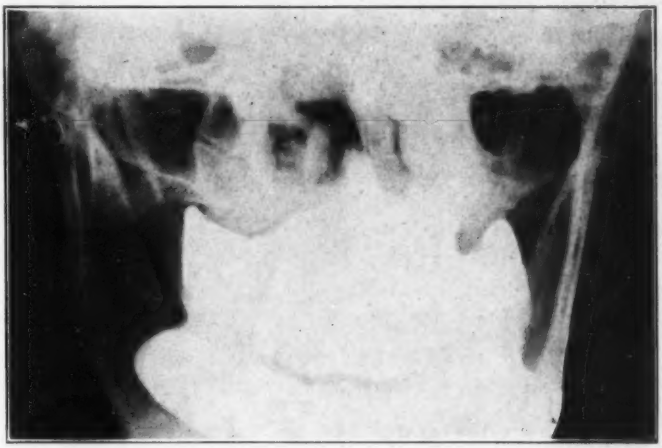


Fig. 23 (Case 8).—Postoperative roentgenogram with denture inserted as intermaxillary splint.

be expected in a child of 12 years. Condylar epiphyseal growth and realinement of the teeth will eliminate minor defects.

*Operative Procedures.*—Silverman (1925)[42] advocated a surgical procedure for reducing condylar fractures with marked displacement consisting of an intra-oral incision along the anterior border of the ramus,

lifting the tissue from the inner surface of the coronoid process and pressing the condyle, by means of a urethral sound, outward and back, while the condylar area was palpated from the outside. When contact had been established, the wires, which had been previously attached to the teeth, were twisted together to effect intermaxillary fixation. This method appeared to have possibilities, although no one has since reported using it. I have tried it for the reduction of a medially dislocated fractured condyle, but found it impossible to push the head of the condyle back into the glenoid fossa, probably on account of the resistance from the capsule that had collapsed. Also, working in a deep wound, guided merely by the sense of touch, is not so easy as it appears to be from Silverman's illustration. The only other writers who advocated operative procedures were Wassmund (1934),[27] who used direct interosseous fixation, and Steinhardt

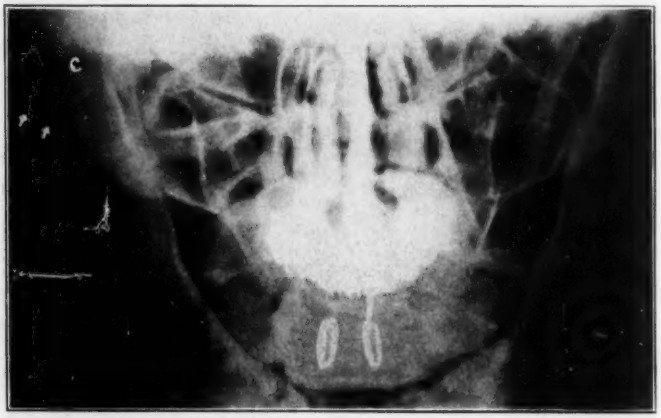


Fig. 24 (Case 9).—Roentgenogram showing condylar fracture with displacement and lack of contact of fragments.

(1936),[25] who recommended that interosseous fixation be used for displaced condyles if there was no hope for union.

In cases of fracture dislocation, which have received very little attention from those writing on the subject of condylar fracture, Strömberg (1934),[43] of a very radical school, recommended condylectomy because of experience with other joints in which luxation of fragments produced arthritis deformans unless there was resetting or extirpation. Bellinger and Henny (1941)[44] reported sequestration of a dislocated condyle with swelling and abscess formation in the right cheek. Berger (1943),[20] like Strömberg, favors complete removal of condylar fragments if they cannot be brought into a satisfactory position by manipulation. Walker (1942),[12] on the other hand, took the position that patients having a condylectomy might

have occlusal disturbances, which were likely to be of greater disadvantage than the changes occurring as a result of fracture dislocation. He recommended condylectomy only in case of severe pain or ankylosis. Steinhardt (1936),[25] who stated, as already indicated, his belief that, in dislocated condyles, a new, well-functioning joint would form through rebuilding of the structures as a result of function, resorted to direct wiring in one case of double condylar fracture with dislocation. This gave good, anatomic, as well as functional, results. He believes that conservative treatment is indicated in fracture dislocation when the proximal and peripheral fragments are in contact, whereas he agrees with Wassmund that, when the proximal fragment is displaced, surgical measures are indicated. Wassmund (1934)[27] believed in extirpation of the condylar fragment and in replanting it after drilling a hole in its neck and head to fasten it to the

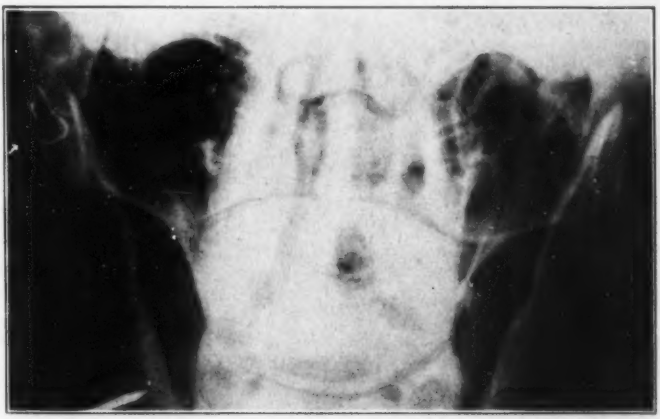


Fig. 25 (Case 9).—Postoperative roentgenogram showing internal wiring fixation and pin in mandible, part of "Frac-Sure" appliance used for fixation of mandibular fragments.

mandible and zygomatic arch with catgut. He had two cases in which, because the condyle became sequestrated, he left the pterygoid muscle attached and drilled the holes without removing the condyle from the wound. He found bone plates and screws unsatisfactory and, for this reason, he used catgut sutures, since he believed that they would hold the condyle in position for from four to five weeks, during which time healing would take place.

### THE IMPORTANCE OF CAREFUL DIAGNOSIS AND TREATMENT PLANNING

A careful study should be made, first, of the condylar injury and,

second, of conditions concerning the positioning and immobilization of the main fragment of the jaw. Good x-ray films should be secured. Lateral jaw films must show the ramus and condyle without interference from the cervical spine (Fig. 14), and an anteroposterior view should give the position of the condylar fragment in a frontal plane. (Fig. 11.) After obtaining a clear mental picture of the condition presented, I try to decide on the treatment for the particular case under consideration. The following may serve as a guide:

Intermaxillary fixation by wiring the teeth or by using a Gunning splint is indicated (1) in all cases in which there is no displacement of fragments (Case 3); (2) in cases with slight overriding of the fragments or intracapsular dislocation with the fragments in contact (Case 4), either condition causing only slight malocclusion, especially in young patients in whom a certain amount of malocclusion arising from a poor anatomic result

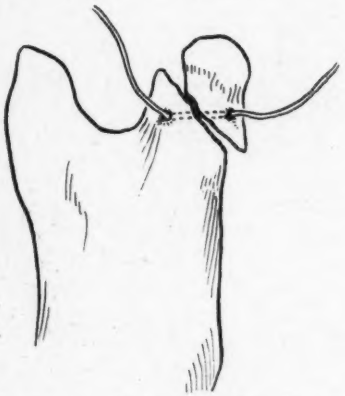


Fig. 26.—Condylar fracture with backward dislocation, wired horizontally.

corrects itself or can be corrected by orthodontic methods; (3) in adults who are partially or completely edentulous when the condyle is not greatly displaced or dislocated, and the resulting malocclusion can be corrected by restoration of the lost teeth with dentures, and (4) in subcondylar fractures in which open reduction is unnecessary or inadvisable because of complications, such as submaxillary swelling or infection.

CASE 3.—*Fracture at Base of the Condyle Without Displacement.*—E. D. (457074), a man, aged 33 years, sustained a fracture of the jaw during a fist fight. He had moderate discomfort on the left side in front of the ear, and on moving his jaw. X-ray examination revealed a fracture at the base of the condyle without displacement. (Fig. 10.) The anteroposterior view showed no dislocation or displacement.

The patient was treated by simple intermaxillary wiring without biteblocks.

His teeth came into occlusion easily and, when the wires were removed, after five weeks, he had satisfactory occlusion, but some stiffness, which he overcame by exercise. One week later, he could eat and could move the jaw without discomfort, and was permanently discharged.

CASE 4.—*Intracapsular Fracture Dislocation with No Displacement of the Fragments, but Displacement of the Meniscus.*—J. S. (464484), a boy aged 17 years, while visiting a sick relative in a hospital, fainted and struck his chin on the floor, sustaining a cut slightly to the right of the median line. He was unable to close the teeth or move the jaw. When he tried to open and close the jaw, there was an abrupt stop with the jaw half way closed.

X-ray pictures revealed a fracture of the left condyle with an intracapsular dislocation of 35 degrees. The fragments were not displaced at the site of fracture (Fig. 11), but it was believed that the meniscus was displaced, thus interfering with the mobility of the jaw.

The patient was admitted to the hospital and, the next day, under pentothal

Fig. 27.—Skull showing wiring and skeletal fixation of dislocated fragments.

sodium intravenous anesthesia, the jaw was manipulated until it could be occluded. Intermaxillary wiring was then applied.

Intermaxillary traction by elastics applied on Jelenko or Winter arches attached to the teeth, or Stout continuous wiring, is indicated: 1. In cases in which there is a tendency of the incisor bite to open. Biteblocks may be placed between the posterior teeth, especially in bilateral fractures (Case 5). The biteblocks should be removed after two weeks and the treatment continued without them for three weeks more. 2. In multiple fractures in which the condylar fragment is in good position or fixed by internal wiring, but the large mandibular fragment or fragments are grossly displaced, causing marked malocclusion. 3. In fractures with malocclusion which are from 1 to 2 weeks old, and in which some callus has already formed. 4. In

open-bite young patients due to overriding or to fracture dislocation (Case 6). 5. In cases to be treated by open reduction, in order to manipulate the jaw during the operation, but at the same time have the teeth pulled back into occlusion when the jaw is released (Case 13).

It is remarkable how quickly occlusion will be obtained by the use of elastics. These should be placed not only vertically, but also obliquely, to bring the mandible, which usually is displaced backward, forward into position. (Fig. 29.) It must not be expected that traction will overcome overriding or correct dislocation of the condyle. In children, epiphyseal growth of the condyle and the eruptive force of the teeth will reestablish normal conditions. Case 2 shows that, in spite of intra-oral and extra-oral traction, overriding was not overcome, but satisfactory healing occurred in a young patient just the same. (Fig. 9.)

Fig. 28 (Case 10).—Roentgenogram showing bilateral condylar fracture dislocation with Jelenko splints applied for fixation of mandibular fracture and correction of open bite.

CASE 5.—*Bilateral Condylar Fracture with Displacement Treated by Intermaxillary Traction.*—D. G., a boy, aged 17, sustained an injury in an automobile accident. He was found to have a compound fracture in the right horizontal ramus with open-bite. X-ray examination revealed bilateral fracture of the condyle, with backward displacement on one side, and lateral displacement of the condylar fragments on the other.

The fracture was reduced under pentothal sodium intravenous anesthesia and, after biteblocks had been inserted, intermaxillary elastics were applied to Stout's type of continuous wiring. These elastics were attached to the anterior part of the jaws in greater number than on the posterior portions.

Intermaxillary fixation was changed after two weeks, when the biteblocks were removed. After four weeks, the number of elastics was reduced, and the entire appliance was removed after six weeks. The patient had considerable trismus and limitation of motion. The occlusion was not so good as had been hoped for, and considerable grinding of the teeth was necessary, beside changing of inlays and the use of fixed bridges to improve it. The final result was good, as far as function was concerned, but it necessitated considerable dental adjustment.

CASE 6.—*Fracture Subluxation with Forward Displacement.*—R. H., a girl, aged 16, had been injured three weeks earlier when her horse stepped on her toe. After going into the house, she fainted and fell against a radiator, striking her cheek. Since then, she had had soreness and a tender spot in front of the right ear, and pain when masticating food. X-ray views taken previously showed no abnormality. New x-ray pictures, taken at this time, revealed a fracture at the neck of the condyle, with the latter completely displaced forward, articulating with the eminentia articularis. (Fig. 13.)

The patient refused open reduction, and the fracture dislocation was there-

Fig. 29 (Case 10).—Open bite due to bilateral fracture dislocation.

fore treated by intermaxillary traction applied to Jelenko splints with a wedge placed between the posterior teeth on the side of the condylar fracture. The biteblock was removed after one week, but the bite was still open in front. At the end of ten days, normal occlusion was obtained. The appliances were removed after five weeks, when there was a good functional result.

Eighteen months later, the patient was found to have a fairly normal occlusion (mandible displaced distally) with normal function. An x-ray picture revealed a somewhat deformed condyle placed anteriorly from its normal location, but the fracture competely healed. (Fig. 14.)

Open reduction with internal wiring fixation is indicated in: 1. Cases of fracture with displacement in which the condylar fragment is grossly malalined with the fractured end at an angle to the ramus and projecting over it on the inside or the outside of the jaw. (Figs. 22 and 23.) 2. Cases with marked overriding and poor occlusal conditions that may be sufficient to

immobilize the jaw, but not sufficient to prevent vertical displacement of the fragments. Examples are cases in which there are no posterior teeth present and no dentures or splints are readily available to hold the jaws apart (Case 7). In such instances, the vertical distances between the upper and lower jaws are decreased considerably, which in edentulous patients will produce a condition unfavorable for denture construction. 3. Fracture dislocations, especially those in which the peripheral and proximal fragments are overriding, whether or not the condyle is fixed after reduction by a skeletal appliance, and especially if the mandible cannot be immobilized immediately and effectively by intermaxillary ligation or otherwise (Case 13). The technic of the operation will be described below.

Skeletal fixation may be employed to hold the reduced fragment in posi-

Fig. 30 (Case 10).—"Frac-Sure" appliance used for fixation after reduction of fracture with dislocation on left.

tion while the fracture heals. It may be used to: (1) hold a dislocated condyle in position after open reduction by a method to be described below and (2) bring a displaced condyle in contact with the mandibular fragment. A half pin may be inserted through a stab incision just below the head of the condyle. Even though it is not possible to prevent overriding and to impact the fracture area by manipulation, the pin may be used to improve the position of the condyle. Contact between the frag-

ments is maintained by attaching the pins to a plaster cap (Fig. 7) or headband (Fig. 34*B*), or to another appliance attached for fixation of another fracture of the mandible, if on the same side of the jaw.

### TECHNIC FOR INTERNAL WIRING FIXATION OF CONDYLAR FRACTURES WITH DISPLACEMENT, AND OF FRACTURE DISLOCATIONS

Before the condyle is operated on, the appliance to be used for immobilization of the mandible should be prepared and attached to the teeth. This eliminates the necessity of opening the mouth for inserting the splints and wires after the condylar fractures have been reduced. There is an advantage in using intermaxillary traction for from twenty-four to forty-eight hours to improve the occlusion and overcome muscular spasm. The elastics do not need to be detached, when the patient is anesthetized by means of

Fig. 31 (Case 10).—Postoperative roentgenogram showing healing of right condyle, which was not reduced, in oblique position, and left condyle, which was reduced, in good alinement.

intravenous pentothal sodium, and an endotracheal tube, used to facilitate breathing or to administer gas, oxygen and ether, can usually be introduced through the nose. In case of emergency, the elastics can easily be removed. Also, before the condylar operations are performed, fractures in other parts of the mandible should be reduced and fixed by some method not requiring immobilization of the jaw, because the mandible must be manipulated in order to reduce the condylar fracture. If the Jelenko splint does not give sufficient fixation for coexisting fractures, a skeletal appliance should be used.

In preparation for the operation, the temporal region is shaved and the skin, including the ear, is prepared in the customary way for a surgical

procedure. Sterile cotton is placed in the external auditory canal. The drapings are adjusted so that a rectangular space is left open, with the longer dimension parallel to the long axis of the ear. An angulated incision is made in front of the ear extending as far as the attachment of the lobe, where the seventh nerve crosses the face. The angulation is made to avoid the auriculotemporal nerve. The correct incision is shown in Figure 20. When the subcutaneous tissue is divided, the superficial orbital artery and vein are cut and tied, blunt retractors are inserted and the zygomatic arch is located. The notch in the inferior border of the arch denotes the location of the mandibular joint. By continuing the dissection downward, the neck of the condyle is found without opening the capsule or injuring the capsular ligaments. Before the neck of the condyle is reached, the

Fig. 32 (Case 11).—Comminuted fracture of right side of mandible and fracture dislocation of left condyle.

transverse facial artery and vein are encountered and cut and tied. The area is rich in small superficial veins, from which, in case of edema, there may be considerable bleeding, which is arrested in the usual manner. The procedure from here depends on whether the condyle is displaced laterally or medially. This, of course, has been determined previously by x-ray examination.

The method of wiring varies somewhat in different types of displacement or dislocation, because of technical difficulties encountered in trying to drill the holes into the fragments. The drilling is done by means of a

dental engine with autoclaved elbow joint and handpiece covered by a sterile sleeve and containing a small spear-shaped drill. If a dental engine is not available, a hand drill may serve. This can be completely sterilized. The motor driven drill is more accurate and safer for so delicate a procedure, since any leverage may splinter the thin condyle and eliminate the possibility of wiring. To prevent aseptic necrosis due to heat generated by the bur, the drilling should be done slowly or the bur should be cooled by a small stream of sterile water, which may come from an intravenous setup connected by a sterile dropper, or from a metal tube attached to the handpiece holding the bur, as devised by Victor H. Carpenter, of Boston. An assistant removes the water with a suction apparatus used to take up blood.

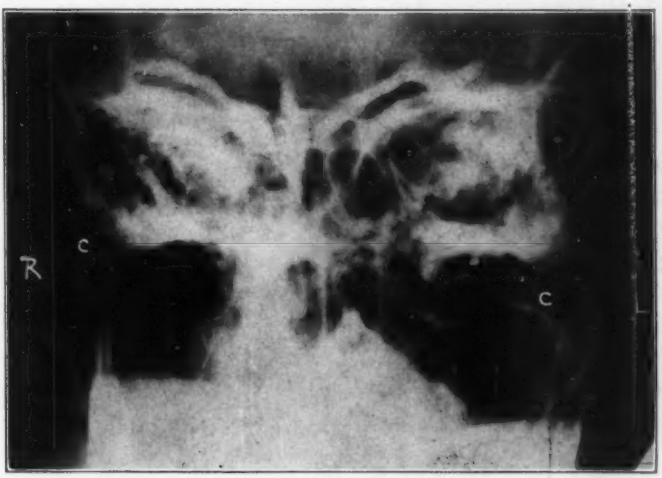



Fig. 33 (Case 11).—Fracture dislocation with malalinement of condyle on left.

In condyles laterally displaced, a vertical incision is made in the overlying periosteum, and, with a periosteal elevator, the outer surface of the condylar neck is laid bare. Here, the hole is drilled in an oblique direction, if possible, extending from the external surface of this fragment to the fracture surface. (Fig. 15*a*.) Drilling the hole obliquely from the outer to the fracture surface facilitates insertion of the wire and decreases the danger of injuring the blood vessels lying directly behind the neck of the condyle. A stainless steel wire, 25 gage, is used. (Fig. 15*b*.)

The mandibular fragment is located next. Since the fragment is under the condyle, the first maneuver consists in reversing its position, by means of a bone file. The small end is inserted obliquely in the fracture line so

that the serrated surface engages the mandibular fragment, which, by lever action exerted by the file (Fig. 15*c*), is depressed until it slides over the condylar fragment and takes a position on the outside of the latter. Usually, the mandibular fragment does not project sufficiently into the operative wound, the extent of which is limited by the facial nerve.

This situation bothered me considerably at first, since it limited the operation to fractures just below the condylar head, but I discovered that, while one cannot pull the ramus down very far because of the accessory ligaments, there is nothing to prevent one from pushing it up. This manipulation can be accomplished by an assistant, who pushes the patient's jaw back by pressing on the chin, or by the anesthetist, who can manipulate the jaw under the drapings. If the teeth interfere, the jaw must be opened as well as pushed back and up, all of which can be done without removing

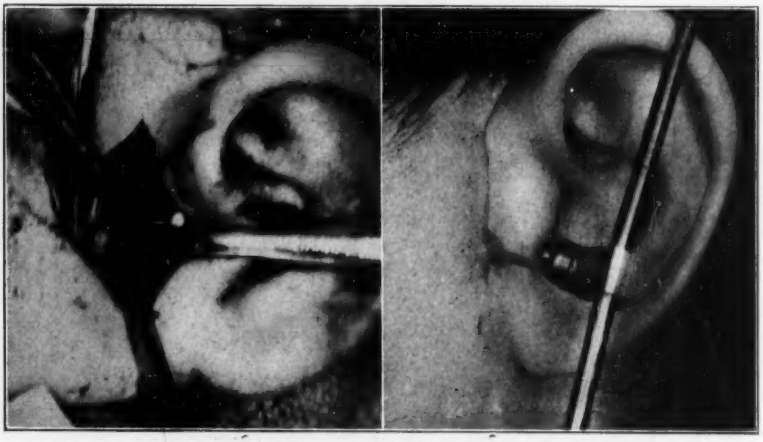


Fig. 34 (Case 11).—Left: Pin inserted in neck of condyle after replantation. Right: Incision healed with pin attached to Woodard headband.

the elastic bands. About 1 cm. of the mandibular fragment can thus be brought into the wound. The periosteum is stripped back with great care so as not to cut or injure the zygomatic branch of the facial nerve. It can often be demonstrated as a fine thread passing here obliquely over the periosteum of the bone. Pinching it gently with a pair of smooth forceps causes a flicking of the eyelid, which is exposed for the test.

A retractor or drill guide (Fig. 15*d*) is now placed in the wound so that it holds firmly on the bone for retraction and protection of the soft tissue, and particularly the nerve, while a second hole is drilled obliquely to the fracture surface. (Fig. 15*d*.) The wire, previously placed in the condylar fragment, is now drawn through from the fracture surface by

inserting a looped wire in the hole from the outer surface of the mandible. (Fig. 15*e*.) The fragments are then impacted by using the same bone file, except that the serrated edge engages the condyle. (Fig. 15*f*.) While this is being done, an assistant pulls on the wire, which guides the fragments into position, since the wire passes through the center of the bone. After the fracture has been reduced, the wire is twisted and cut off so that about 0.5 cm. of twisted wire remains. This is bent over close to the bone. The subcutaneous tissues are now closed with catgut 00; a rubber dam drain, to be removed in twenty-four hours, is inserted to prevent the formation of a hematoma, and the skin is closed with a subcuticular or interrupted suture.

Fig. 35 (Case 11).—Woodard headband with one rod immobilizing condyle and two rods attached to pins inserted in mandible for immobilization.

(Fig. 20.) Several pieces of gauze are applied over the wound, with a bandage to produce moderate pressure. Patients presenting such injuries usually have been placed on chemotherapy, and this should be continued postoperatively.

In condyles medially displaced (Fig. 16*a*), the procedure is reversed. First, the mandibular fragment is located by manipulation and by pushing the ramus up into the wound, as described previously, without contamina-

tion of the gloves of the operator or his assistants with oral secretions. Here again, care should be used to prevent injury to the facial nerve in dissecting and drilling the hole. (Fig. 16*b*). The wire is inserted in the mandibular fragment first, and then the condyle is brought to the outside with the aid of the file. (Fig. 16*c*.) After the hole has been drilled in the condylar fragment in the manner previously described (Fig. 16*d*), the wire is again drawn through this fragment by means of another wire bent upon itself. The fragments are finally impacted by bringing the mandibular fragment into apposition by means of the bone file, the serrated edge pointing down to take hold of the mandible, and by use of the file to apply leverage. (Fig. 16*e*.) The wire is again twisted to hold the fracture in the reduced position and is cut and bent. (Fig. 16*f*.) The wound is finally closed as previously described.

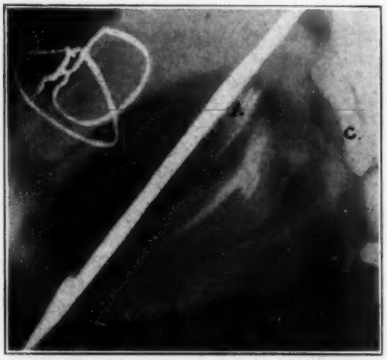



Fig. 36 (Case 11).—Roentgenogram showing fracture of coronoid process (*A*) and fracture of condyle (*C*), still with backward displacement after reduction.

Forward and backward displacement does not generally affect the operative technic. Either medial or lateral displacement of the condyle is always associated with forward dislocation, so that one or the other of the procedures described is indicated. In backward dislocation, the operation is simpler than in the medial and lateral types. The two fragments are in the same sagittal plane and the suture may be placed horizontally instead of vertically. (Fig. 26.)

The following cases are examples of these operations:

CASE 7.—*Comminuted Fracture of the Mandible with Fracture of the Right Condyle, with Medial Displacement and Overriding.*—R. R. (438182), a man, aged 28, referred to the Massachusetts General Hospital from a local hospital, had been in an automobile accident in which he suffered bruises and fracture of the jaw.

Examination revealed slight swelling of the face with a few minor lacera-

tions, movement, crepitus and pain on manipulation of the jaw. The mouth was in poor condition hygienically, with many badly decayed teeth and a mild form of Vincent's stomatitis present.

X-ray examination revealed a transverse fracture at the base of the neck of the condyle on the right, with considerable overriding and medial displacement. (Fig. 17.) In the lateral view, there was considerable angulation between the ramus and the fractured condylar process of the jaw. There also was found a comminuted fracture of the left mandible in the area of the mental foramen, with the teeth in this area involved and one displaced.

Three days later, an open reduction of the compound comminuted fracture of the mandible was performed. There were at least five fragments, which were gathered together by a circumferential wire, after which skeletal fixation was applied.

An open reduction of the condylar fracture was performed. There was considerable bleeding, due to edema. The fracture was reduced and impacted, and a wire inserted and twisted with the wire twisters for fixation. (Fig. 18.)

Fig. 37 (Case 11).—Roentgenogram showing postoperative result ten months later. (Compare Figure 36.) The replanted condyle is attached to the jaw with good functional results, although not entirely satisfactory from an anatomic point of view.

After the wire had been cut (Fig. 19) and the end turned down on the bone, sulfanilamide powder was inserted and the incision was closed with interrupted sutures. A rubber-dam drain was inserted in the fracture area between two of the stitches to take care of bleeding. (Fig. 20.) Postreduction x-ray examination revealed that the condylar fragments were in good position when viewed from an anteroposterior projection. (Fig. 21.)

An intra-oral splint was constructed and placed in the mouth after a few days, and a Barton bandage with rubber band traction applied. The half pins used for skeletal fixation were removed in the outpatient department one month after operation. At this time, the fractured bone was firm and there was no evidence of infection. The patient had satisfactory function of the jaw. Hinge as well as lateral motion was good. He had slight paresis of the right eye due to injury of the zygomatic branch of the facial nerve. When

seen again two months after the operation, this condition had improved considerably, and the patient was permanently discharged.

CASE 8.—*Fracture of the Neck of the Left Condyle with Lateral Displacement and No Contact of Fragments.*—L. L. (447439), a Finnish woman, aged 65, referred for treatment of a fracture of the ramus of the left mandible, also had a fracture of the left second rib anteriorly. She allegedly struck a post while driving her car the afternoon before admission. A letter from her local doctor stated that she was taking 60 units of insulin daily to control diabetes.

She complained of pain over the chest, but no special pain in the jaw on motion, speaking or light palpation. There were two sutures in the point of the chin and two in the mucosa of the lower lip. On palpation, pain was evinced in the left mandible high up in the ramus. On attempted excursion laterally, crepitus could be felt.

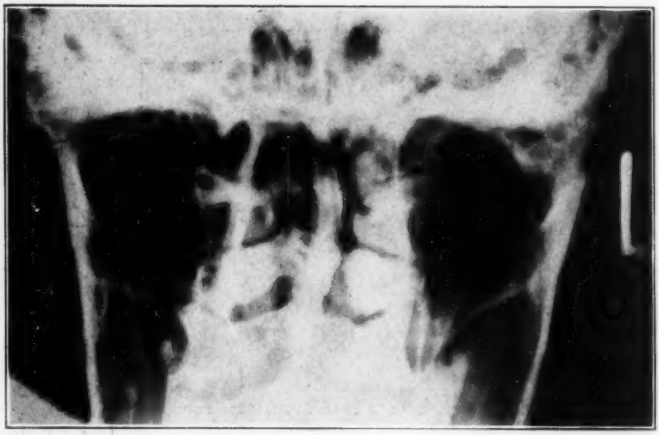


Fig. 38 (Case 11).—Anteroposterior view taken ten months after replantation of condyle. The angulation is due to difficulty in immobilization of the comminuted fragments of the mandible.

X-ray examination of the mandible revealed a fracture of the neck of the left condyle with considerable lateral tilting of the condyle fragment. (Fig. 22.) Jaw reduction was delayed until the diabetes was fairly well controlled. Under endotracheal nitrous oxide, oxygen and ether anesthesia, an open reduction of the fractured condyle of the mandible was performed with internal wiring fixation. The dentures were wired together and used as an intra-oral splint with a Barton bandage.

Postoperatively, the patient had no pain or swelling. X-ray examination showed the fragments to be in a markedly improved position. (Fig. 23.) The patient was discharged from the hospital three days later, the case to be followed in the outpatient department. After ten days, the sutures were removed,

and, on the twenty-first postoperative day, the splints were remade into dentures. The patient was found to have good function of the jaw and normal reaction of the facial nerve. In this case, the presence of the zygomatic branch of the facial nerve had been demonstrated during the operation.

CASE 9.—*Fracture of the Mandible and Left Condyle with Lateral Displacement and No Contact of the Fragments.*—L. L. (448900), a man, aged 42, ten days before admission, during an alleged dizzy spell, fell and struck his jaw. He thought nothing of it until a week later when he noted a somewhat painful swelling in front of the left ear and felt sudden pain and crepitus as he was chewing a sandwich.

Physical examination revealed a protrusion of bone on the left side of the face just in front of the lobe of the left ear. X-ray examination revealed a fracture at the neck of the left condyle with lateral displacement. (Fig. 24.)

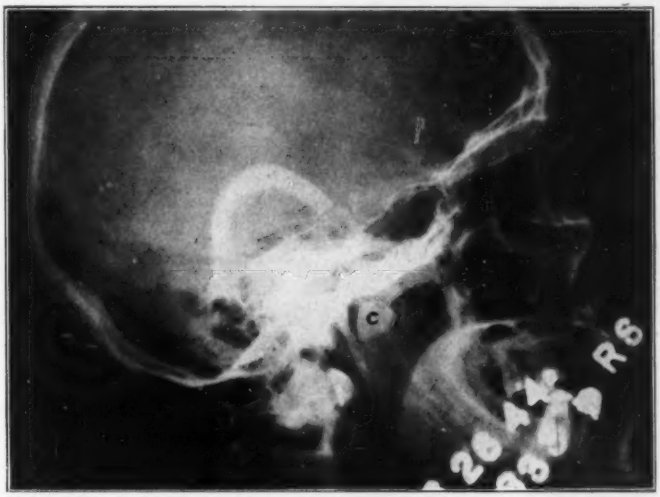



Fig. 39 (Case 12).—Condylar fracture with dislodged part of condyle (*C*) in pterygoid fossa.

The lateral jaw x-ray film showed, in addition, fracture in the horizontal ramus of the mandible on the same side. The mouth was completely edentulous.

Under intratracheal nitrous oxide, oxygen and ether anesthesia, the condylar fracture was reduced by open operation and fixed by intraosseous wiring. After sulfanilamide powder had been inserted, the subcutaneous tissue was closed with catgut sutures. A small rubber-dam drain was inserted and the skin closed with a subcuticular suture. The mandibular fracture was treated by skeletal fixation ("Frac-Sure" appliance). A postoperative x-ray film showed the fragments well alined. (Fig. 25.) Edentulous splints were placed in the mouth and a Wilson bandage was applied. After three weeks, the fracture seemed to be well consolidated. The intra-oral splints and "Frac-Sure" appli-

ance were removed. Four weeks after the operation, the patient could move the jaw freely. There was good hinge, lateral and forward motion.

### TECHNIC FOR SKELETAL FIXATION OF FRACTURE DISLOCATIONS

One of the difficulties in fracture dislocation is interpretation of the x-ray films in order to determine the exact location of the condyle. A stereoscopic view will give valuable information not readily discovered in an ordinary film. When a subluxation is reduced by an open operation, the condyle is usually easily found and reduced, and wiring of the fracture by the method described will, as a rule, hold it in place. In complete dislocation in which the condyle has slipped out of the capsule, usually on the medial side, the neck may be projecting over the fractured surface of the ramus, or may be close to it so that it can be located without trouble. If the condyle is dislodged, the external pterygoid muscle may have pulled it

Fig. 40 (Case 12).—Condylar fragment repositioned and wired.

some distance away from the glenoid cavity, so that it must be searched for deep in the pterygoid fossa. It may be displaced downward, inward and forward. (Fig. 33.)

The same preparation and incision previously described are used for reduction of a fracture dislocation. In lateral dislocation, the condyle is encountered as soon as the incision has been made, and, after reduction and wiring, the fracture is held in place by careful suture of the capsule. In medial dislocation, the condyle may be located behind the mandibular fragment, which may have been pulled up in contact with the glenoid fossa by muscular spasm.

In such instances, the zygomatic arch is exposed and the glenoid cavity located. It is found under the notch at the inferior border of the zygomatic

arch, posteriorly from the articular eminence. The outer capsular ligaments are incised, and the meniscus, which generally remains *in situ,* is carefully inspected. If comminuted, it should be excised. The mandibular fragment is exposed and pulled down by means of a retractor or a hook inserted at the lower end of the incision. This generally brings the neck of the condyle within view and allows it to be pulled back into the glenoid fossa by means of hooks. A hole is drilled on its external surface near the junction of the head and neck while it is held with bone forceps or retractors placed behind the fragment.

If the condyle is completely dislodged, its location may cause considerable difficulty. Old blood or partly organized hematoma may fill the pterygomandibular space, and must be removed carefully without injuring the internal maxillary vessels or their branches. Fresh bleeding, which

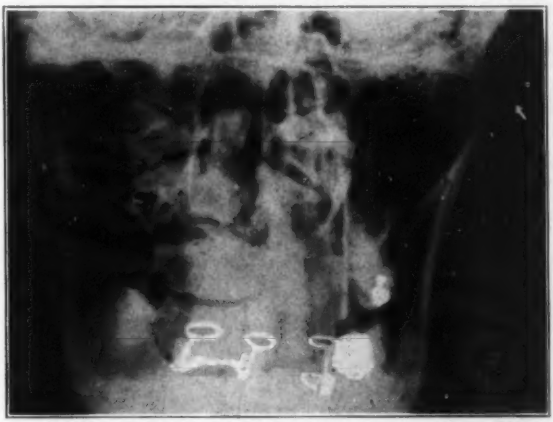


Fig. 41 (Case 12).—Postoperative roentgenogram showing wire fixation of condylar fragments.

usually ensues, is stopped by placing adrenalin packs in the wound. Then the region is systematically explored by probing and wiping with small gauze tampons until the shiny articular surface of the condyle is discovered. When found, the condyle is grasped with small Kelly forceps, hooks or bone forceps, without injury to the articular cartilage, and pulled back into its normal place.

A great deal of attention should be paid to positioning a dislocated condyle. Tweezers should be used to rotate it until the head fits into the joint fossa and the fracture surface against that of the ramus. While it may be possible, even in these cases, to keep the condyle in the reduced position by fixation of the fracture only, this type of fixation is not always

satisfactory or adequate in complete dislocation, and particularly not with dislodged condyles. This is especially true in case of bilateral condylar fracture because, when the second condyle is operated on, manipulation of the jaw (pressing the chin back) in order to wire the ramus may cause a new dislocation.

In these cases, it is advisable to use, in addition, skeletal fixation for the head of the condyle (Fig. 27), by which the latter can be controlled even after the wound is closed. At first, I used skeletal fixation alone, but I believe that such cases will do better if the fracture is wired also. When Cases 10 and 11 were treated, the wiring method had not been perfected, and skeletal fixation alone was depended on to hold the condyle and the fracture in place. The result was satisfactory, but not perfect, because of the difficulty in stabilizing the edentulous mandible, which was comminuted

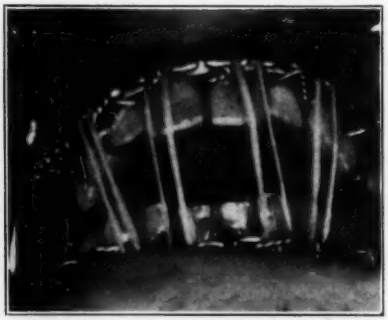


Fig. 42 (Case 13).—Open bite due to bilateral fracture of condyle with dislocation on right. Jelenko splints were used for elastic traction.

and compounded into the mouth. In such cases, wiring of the fracture in addition to skeletal fixation should give better results.

In Case 14, therefore, in which both condyles were wired, the condyle with medial dislocation was also fixed by means of a "Frac-Sure" appliance. The result was good except for some angulation. (Fig. 45.) This, I believe, was due to the spreading apart of the rami because of the fracture at the symphysis. Since the operating procedures tend to pull the rami out, care should be taken to push the wired fracture fragments medially to overcome such angulation before closing the wound. Also, the Jelenko splint on the lower teeth should be bent so as to press the jaw together in the molar region.

The pin is inserted, while the condyle is held with bone forceps or retractors. A hole is drilled on its external surface with a spear-shaped drill. Then the pin is carefully inserted. To immobilize the condyle, the half pin may be attached to a headband by means of a connecting rod (Fig.

34*B*). The headband connection has not proved very satisfactory, because slight movement may displace the condyle, especially while the patient is sleeping. In two cases, therefore, I have immobilized the condyle by inserting a second pin in the eminentia articularis to hold the condylar pin by means of a short "Frac-Sure" connecting rod. (Fig. 30.) This pin is inserted in the previously drilled hole under direct vision through a stab incision in the skin flap. After a connecting bar has been attached by means of "Frac-Sure" links, the subcutaneous tissues are closed with catgut and the skin with interrupted sutures or a subcuticular suture. (Fig. 30.) No drain is inserted since the pin will serve to take care of any oozing of blood after the operation. The incisions may be coated with collodion or tincture of benzoin, and a pressure bandage is applied over the dressings arranged around the pins. The jaw is then immobilized for from three to four weeks. The pins may be removed after from one to three weeks, and after four weeks the patient is allowed to move the jaw moderately.

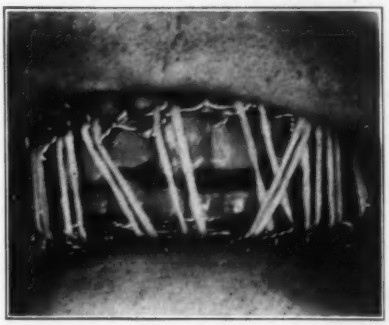


Fig. 43.—Partial closure of bite after forty-eight hours.

If intermaxillary wiring has been used, immobilization of the jaw is accomplished by attaching intermaxillary elastic bands to Kazanjian buttons fashioned from some of the wires attached to the teeth. These elastics restrict motion satisfactorily. If Jelenko splints have been used, restricted function is made possible by decreasing the number of elastics gradually. After five weeks, the patient may begin to masticate food. It should be kept in mind that, in many cases, normal function cannot be entirely regained until after several months, when rebuilding of the condylar structures and those of the glenoid cavity has taken place, owing to the fact that it is very difficult to position the fractured condyle accurately. In some instances, exercises must be prescribed to aid in regaining the normal excursion of the mandible.

Condyles that are completely detached from all structures may be salvaged by this method. A replanted condyle gives a much more satis-

factory functional result than would a bone graft, even when slightly displaced. It can unite and function well, as in Case 11.

CASE 10.—*Fracture of the Mandible with Bilateral Medial Fracture Dislocation and Overriding of the Fragments.*—P. B. (435576), a boy, aged 17, who had been in an automobile accident, presented a compound fracture of the right leg and multiple lacerations of the face. The patient also had marked malocclusion, probably due to the mandibular fractures. X-ray examination revealed that the skull was not fractured, but there was a fracture of the mandible to the right of the symphysis and bilateral fracture dislocation with marked lateral displacement of the condylar fragment on the left. (Fig. 28.)

The patient received chemotherapy. The scalp wounds were sutured and the fractured tibia plated by the surgical department. February 8, the frac-

Fig. 44 (Case 13).—Bilateral fracture of mandibular condyles with dislocation on right and medial overriding of condyle on left.

ture in the anterior part of the mandible was treated by skeletal fixation under local anesthesia and sedation. Jelenko splints were applied to close the bite and elastic traction to restore normal occlusion, disturbed by the condylar fractures. (Fig. 29.) The occlusion was reestablished by February 11, and it was decided to reduce the fracture dislocation on the left, which was more serious than that on the right, by open reduction and skeletal fixation, with the hope that, by reestablishing occlusion, the right condylar fracture would be in a sufficiently good position to take care of itself. The operation was performed February 15. Under endotracheal nitrous oxide, oxygen and ether anesthesia, the usual incision was made and the zygomatic arch exposed, par-

ticularly the eminentia articularis. The empty joint cavity was located, after which the dislocated condyle was found deep in the wound and put back in the glenoid cavity. While it was held with bone forceps, a hole was drilled just at the junction of the condylar head and neck, and a half pin inserted. Another hole was drilled in the eminentia articularis and a second pin inserted through a stab incision in the skin flap under direct vision. A "Frac-Sure" connecting bar was attached by which the condyle was immobilized. The incision was closed with the condylar pin projecting between the two sutures. (Fig. 30.)

Recovery was satisfactory and the patient was discharged to the outpatient department February 19. The pins holding the repositioned condyle were removed March 8 and the mandibular appliance and Jelenko splints March 15. The occlusion was not so good as expected, partly owing to the fact that the

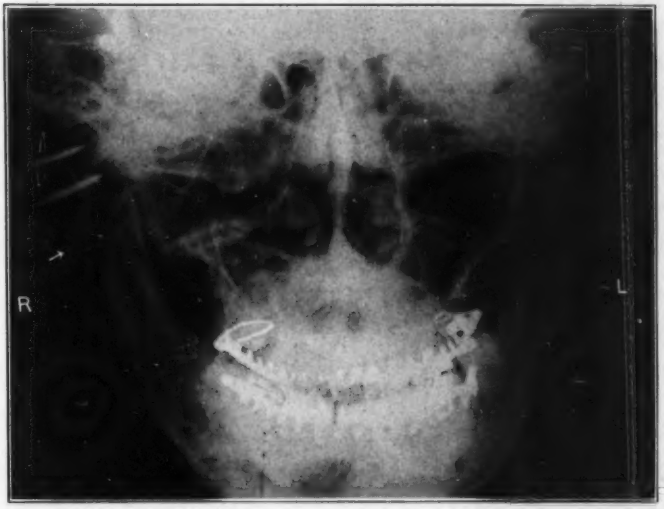


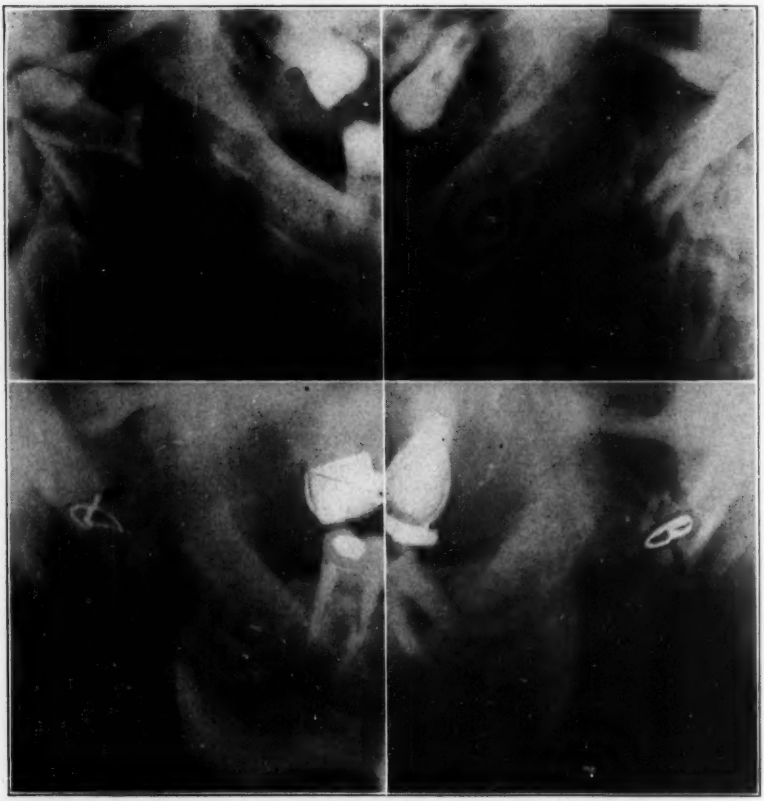

Fig. 45 (Case 13).—Postoperative roentgenogram showing reduction of fracture with dislocation on right, employing skeletal fixation and wiring, and reduction and wiring on left. Jelenko splints were used to reduce the fracture at the symphysis and to immobilize the jaw.

patient removed the rubber bands at home while under treatment, and partly because only one side had been operated on. The teeth were ground to occlude and two were extracted, which improved the condition. The patient was permanently discharged May 24 with a fairly good function of the jaw, and no neurologic facial disturbance. The final x-ray examination (Fig. 31) revealed great improvement in the position of the left condyle, good union of the dislocated right condyle and complete healing of the fractures.

CASE 11.—*Comminuted Fracture of the Mandible and Maxilla with Fracture Dislocation and Dislodgment of the Condyle.*—R. C. (428844), a woman,

aged 34, admitted to the hospital November 27, 1943, after an automobile accident occurring a week before, presented besides facial lacerations, ecchymosis around both eyes and right cheek and hemorrhage from the left ear, a comminuted fracture of the right mandible with a submucosal hematoma, fracture of the left maxilla, and of the left coronoid process and fracture dislocation of the condyle. (Figs. 32, 33 and 36.)

Sulfadiazine therapy was instituted at once. November 29, under gas-oxygen-ether anesthesia, the mandibular fracture was treated by internal wiring fixation



Figs. 46-49 (Case 13).—Above: Lateral views showing condylar fractures on left and on right with displacement. Below: Lateral views showing internal wiring fixation.

after removal of a large hematoma. December 3, under pentothal sodium intravenous anesthesia, an operation for reduction of the displaced and dislocated condyle fracture was performed. After the usual preparation of the shaved temporal region and the skin anterior to the ear, the latter being plugged with

cotton, an angulated vertical incision was made in front of the ear, extending as far as the attachment of the lobe of the ear to the face. The tissue was divided and the transverse facial artery and vein were located, cut and ligated. The subcutaneous tissue was then dissected and the zygomatic arch located and exposed.

When the glenoid fossa was found, the meniscus was still partly attached, but the condyle was completely detached and dislocated. After blunt dissection, it was located in the pterygoid fossa in the anterior and medial position indicated in the x-ray film. (Fig. 2*c*.) It could be grasped with bone forceps and elevated into a position which allowed a hole to be drilled just below the condylar head. A half pin was inserted, by which the condyle could be immobilized. (Fig. 34*a*.) The assistant, manipulating the mandible under the drapings, helped impact the fragment against the ramus, and thus the condyle was completely replanted. The subcutaneous tissue was closed with catgut sutures, and the skin with a subcuticular suture. The pin, which extended through the

Fig. 50 (Case 14).—Patient with face lacerations and multiple mandibular fractures including bilateral fractures of condyle.

incision, was to serve as a drain for oozing blood and for fixation of the condyle to the headband. (Fig. 34*b*.)

Since the patient was edentulous and had lost her dentures when the accident occurred, the mandible was immobilized by inserting a half pin on each side of the chin, and attaching these by means of "Frac-Sure" links to the extension rods from the headband previously described. (Fig. 35.) The headband, therefore, served to hold the condyle in position and to prevent motion of the mandible.

X-ray pictures taken December 6 showed the comminuted fracture of the horizontal ramus satisfactorily reduced. The condyle, though somewhat angulated, was in contact with the ramus and held in the glenoid fossa by a half pin. The angulation was probably due to the instability of the headband that held the mandible immobilized by means of rods attached to half pins inserted in the chin, and the lack of posterior support of the jaw, which was edentu-

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lous. Splints were deemed inadvisable because of the extensive area involved by the mandibular fracture on the right and the reduction by an intra-oral operation, which required circumferential wiring as well as suturing.

December 19, under pentothal sodium anesthesia, with an intratracheal tube inserted and a postnasal plug placed in the nasopharynx, the right maxillary sinus was opened because of pain. A slow, interrupted hemorrhage that resulted was arrested by means of adrenalin packs and packing the sinus with petrolatum gauze, which also served to decompress the walls of the sinus that were collapsed. The pack was removed with great precaution under gas-oxygen anesthesia.

The patient continued to do well. The pin in the condyle was removed January 7, 1944, but there was still a swelling in front of the ear, although the pin wound had completely healed. January 14, a stab incision at the site

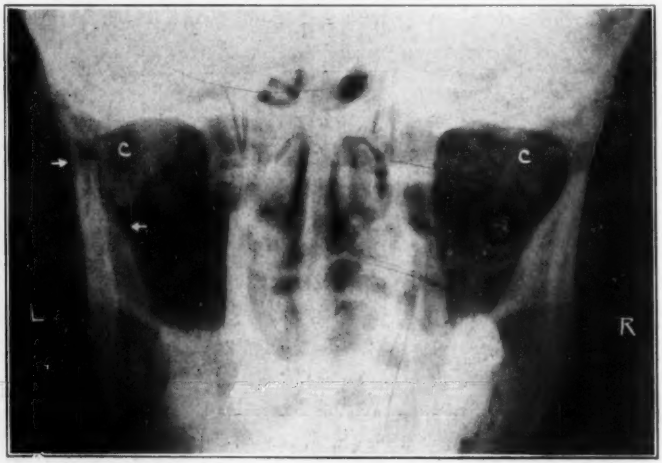


Fig. 51 (Case 14).—Roentgenogram showing fracture with medial overriding on left and fracture dislocation with comminution of right condyle.

of the insertion of the pin released a small amount of pus, which, on culture, yielded *Staphylococcus aureus*. The fistula was then treated every five to six hours with zephiran injected into the wound. A Gunning splint was constructed, as the fracture in the mandible had completely healed. It was thought that the splint would immobilize the jaws more effectively, and take pressure off the condyle. I had some penicillin left from another patient, which I injected several times a day into the fistula, instead of zephiran, in a dilution of 500 units per cubic centimeter. After seventeen days, the discharge had been completely arrested, the fistula having closed spontaneously.

March 20, the patient's jaw functioned satisfactorily, and she had new dentures made. She was seen again September 22, ten months later, and the anteroposterior view showed the condyle articulating, though still angulated.

(Fig. 38.) The lateral view showed that the fractures of the condyle and coronoid process, which remained separated after the reduction (Fig. 36), had been completely connected by bone. (Fig. 37.)

*Comment.*—The angulation of the condyle at its attachment to the ramus was, at the time, thought to be due to improper positioning, but, since the experience with Case 13, it is more easily explained by the divergence of the rami, which occurs in all multiple fractures involving the horizontal rami and the condyle as well. In a comminuted fracture with no teeth present, as in the case presented, it is difficult to estimate the width

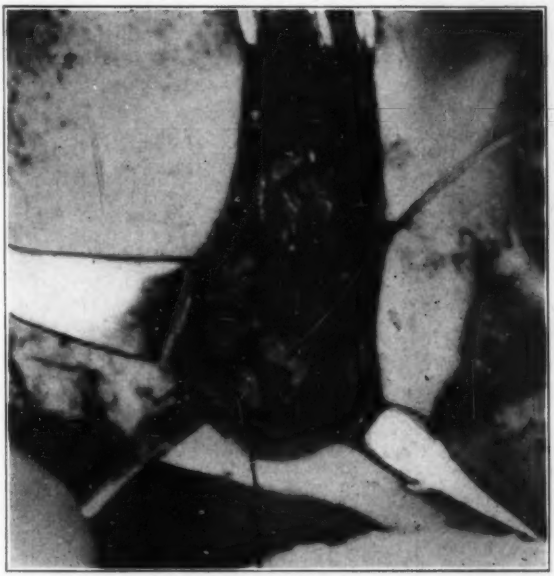

Fig. 52 (Case 14).—Wiring of left condylar fracture.

of the dental arch, and restoration of the distance between the rami is not easily accomplished.

CASE 12.—*Fracture Dislocation of the Condyle Dislodged and Found in the Pterygoid Space.*—H. D. (293337), a man, aged 45, involved in an automobile accident two days before, presented lacerations of the face, a fractured jaw and bleeding from the right ear. X-ray examination revealed a fracture through the right condylar head with forward, downward and medial dislocation of the condylar fragment. (Fig. 39.) An open reduction was performed June 30 under endotracheal gas, oxygen and ether anesthesia. The dissection was carried out as usual. The zygomatic branch of the facial nerve was ex-

posed and, when it was pinched, a reflex of the eyelid was seen. This nerve was carefully protected with a retractor. The fracture was found to be an intracapsular one starting at the cartilage on the lateral surface of the condyle and extending obliquely down to its neck on the medial aspect. (Fig. 2.) The condylar fragment had been dislocated and displaced forward and down along the inner surface of the ramus, where it was located with considerable difficulty. It was pulled back into the joint cavity and, while it was held with a sharp hook and retractor, a hole was drilled through both the mandibular and the condylar fragment. A wire, inserted and twisted, held the fragment in a satisfactory position. (Fig. 40.)

Immobilization of the mandible was accomplished the next day by interdental wiring of the anterior teeth in the upper and lower jaw. Chemotherapy, which had been started on admission, was discontinued July 5. The postoperative x-ray picture showed a satisfactory position in both the lateral and the anteroposterior views. (Fig. 41.) July 13, the intermaxillary wiring was

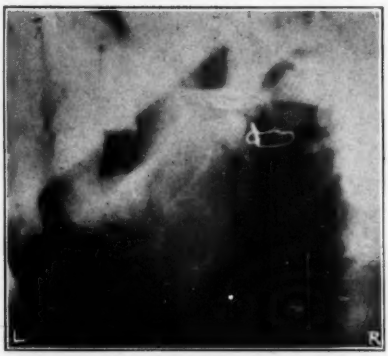


Fig. 53 (Case 14).—Postoperative roentgenogram showing internal wiring fixation of left condylar fragments.

replaced by intermaxillary elastics, allowing restricted motion. July 20, the patient was allowed free movement of the jaw. He complained of occasional shooting pain in the temporal region August 17. At this time, he had a better than fair function of the jaw.

It is expected that, by means of judicious exercises, normal function will be established in due time. On careful examination, there was no defect found in the functioning of the facial nerve. When seen September 27, the patient could open the jaw without pain, and had adequate lateral motion. He complained of an occasional shooting pain over the temporal region of the head.

CASE 13.—*Bilateral Fracture of the Mandibular Condyles with Fracture at the Mandibular Symphysis.*—R. F. (464422), a man, aged 42, was brought to the emergency ward after an automobile accident in which he struck his

chin on the windshield. He did not lose consciousness, and there were no other injuries.

On examination, the patient was found to be suffering from (1) a fracture of the mandible to the right of the symphysis between the right first and second incisors with displacement, and compounded into the mouth; (2) fracture dislocation of the right condyle of about 80 degrees medially with contact of the fragments; (3) fracture of the base of the neck of the condyle with displacement on the left, and (4) open-bite due to impaction of the fragments in condylar fractures and spasms of the elevator muscles. (Figs. 44, 46 and 47.)

A temporary reduction with horizontal wiring of the anterior fracture was carried out and a Barton bandage applied. The next day, Jelenko splints were wired to the upper and lower jaws, and intermaxillary elastics were applied in the anterior part of the mouth to close the open-bite and bring the teeth

Fig. 54 (Case 14).—Internal wiring fixation on left and condylectomy on right.

into occlusion. (Fig. 42.) The open-bite was improved with this treatment, but was not completely relieved after forty-eight hours. (Fig. 43.) This was believed to be due to the excessive elevation of the ramus made possible by the bilateral condylar fractures and dislocation. Therefore, it was believed that open reduction would give the most satisfactory results.

Two days later, an open reduction of the fracture dislocation of the right condyle was performed. After the usual premedication and, under pentothal sodium anesthesia, an angulated vertical incision was made in front of the right ear extending to the attachment of the lobe. The subcutaneous tissue was divided, and the superficial orbital arteries and veins were cut and ligated. The zygomatic arch was exposed and the joint cavity was found to be empty.

The capsule and the temporomandibular ligament were intact on the external side. The neck of the condyle was exposed and found to be fractured at the base obliquely across from the mandibular notch to the posterior border of the ramus. The condylar fragment was found completely detached from the capsule, but it was attached to the external pterygoid muscle by a few muscle fibers. An oblique hole was drilled into the condylar fragment from the external surface to the fracture surface. Then the condyle was placed medially by means of a bone file and, by pressing on the chin, the mandibular fragment was brought into the incision. A hole was drilled here also from its external surface to the fracture surface.

A sterile stainless steel wire, 25 gage, was inserted through the two holes, and after the fragments were properly impacted, the wire was tightened, cut and bent. The head of the condyle was then pulled into the capsule by means of hooks. While it was held in position with retractors, a hole was drilled into its lateral surface at the junction of the head and the neck. Another half

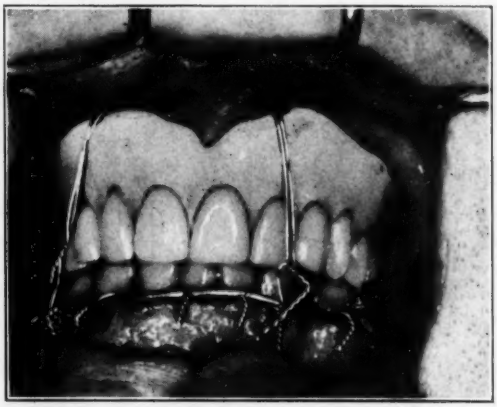

Fig. 55.—Immobilization of mandible in condylar fracture by means of stainless steel wires inserted in margin of piriform aperture of nose and attached to arch wire on lower teeth to lock full denture in upper jaw.

pin was inserted in the eminentia articularis and was brought out to the surface through a stab incision in the skin. The capsule was sutured with catgut. After the wound had been closed, the condyle was positioned, and a bar attached to the two pins in such a manner that the condyle was pulled in an outward direction, and thus was completely fixed in its reduced position. A dressing and an elastic Barton bandage were applied.

Four days after the first operation, the second operation was performed on the left. The condyle was found displaced medially as well as forward. The mandibular fragment came into view when the chin was pressed back. A hole was drilled through the fractured end for the insertion of a stainless steel wire, 25 gage. The condylar fragment was located and, by means of a bone file, was moved from the medial side to the external side of the ramus, while

its head was held with bone forceps. A hole was drilled through the neck of the condyle, and a double wire inserted, by means of which the wire in the other fragment was drawn back. The fragments were then impacted, the fragments placed in good position and the wire made taut, twisted, and cut off. The wound was closed. A dry dressing was applied to the face around the pins. The occlusion was locked by placing a brass wire around two lugs of the splints, one on each side. Postoperative x-ray films are shown in Figures 45, 48 and 49.

The day after the second operation, there was some discharge around one of the pins inserted at the first operation. Culture showed hemolytic *Staphylococcus aureus,* sensitive to penicillin. The patient was immediately placed on penicillin, 10,000 units intramuscularly every three hours and, in addition, from 1 to 2 cc. of a solution of 500 units per cubic centimeter was injected into the wound every three hours. There was some discharge for three days, and a little swelling, which disappeared after seven days. Otherwise, the patient progressed satisfactorily. He was discharged eight days after the second operation, the case to be followed up at the office.

Four weeks after the second operation, the intermaxillary wires were removed, and the patient was allowed some motion, restricted by two elastics. After another week, the splints were removed. At this time, the mandibular fracture was firmly united, but the patient had slight muscular spasm, which limited the motion of the jaw. With exercises, this condition subsided promptly.

*Comment.*—The clinical result in this case was excellent, although the reduction was not anatomically perfect, as it was in some of the other cases that were wired by this method. In the x-ray picture (Fig. 45), angulation of the condyles is revealed. This was not due to medial dislocation, but to a spreading of the jaw. An anterior fracture, when present, acts as a hinge, allowing the rami to diverge. This divergence does not occur when there is no fracture in the horizontal rami, but it is easily observed if there are good occlusal possibilities. The operative procedure tends to displace the fragments outward, and, in such fractures as the one described, care should be taken to push the wired fragment medially before closing the wound. Also, some spring put into the Jelenko arch attached to the mandible might help to press the molars inward.

### CONDYLECTOMY IN COMMINUTED CONDYLAR FRACTURES

Although the blood supply is generally interfered with in fracture dislocation of the mandibular condyle, the fragments will, in most instances, remain viable, and the joint will readjust itself so as to function satisfactorily if the condyle is replanted. In comminuted condyles, the prognosis is not so good, and the fragments may have to be removed. They are located in the manner described for displaced noncomminuted condyles, and are removed after being cut loose from the external pterygoid muscle. (Fig. 54.) The mandibular stump is then smoothed by means of rongeurs and bone files. If there is persistent hemorrhage, the bleeding may be stopped by

the use of adrenalin packs, or the cavity may be packed with fibrin foam soaked in thrombin, a material developed by the department of physical chemistry at Harvard Medical School. Some muscle or fascia may be drawn over the fractured surface, but this is not absolutely necessary. The subcutaneous tissue is closed and the skin sutured, as previously described. Motion of the jaw is restricted for two to three days, after which it is encouraged.

CASE 14.—*Compound Fracture of the Mandible with Fracture Dislocation of the Condyle and Medial Displacement on the Left, and Fracture Dislocation with Comminution of the Condyle on the Right.*—J. M. (438269), a housewife, aged 28, brought to the emergency ward by ambulance February 24, 1944, was found to be suffering from compound fracture of the right femur, a subtrochanteric fracture of the left femur, a deep laceration of the anterior surface of the left knee, which laid open the joint, lacerations over the left eyebrow, nose and lip, compound multiple fractures of the mandible (Fig. 50), fracture of the left inferior pubic ramus, and probably a ruptured bladder.

The patient had contracted these injuries in an automobile collision, but she did not lose consciousness. On arrival, she was given a transfusion of 1,000 cc. of whole blood.

An open reduction of the right femur with plating was performed by the orthopedic staff, and sulfadiazine therapy instituted. The patient developed pericarditis, doubtless traumatic in origin, February 26, and she was given an intravenous injection of 2,300 cc. of a saline solution, vitamins, 5 gm. of sulfadiazine and an ampul of calcium lactate. February 28, she received a transfusion of 500 cc. of whole blood, and the lacerated skin over the jaw was sutured, with temporary fixation of the jaw by wiring the lower teeth under local anesthesia. Plating of the left femur was carried out March 6, when she was again given a transfusion of 500 cc. of whole blood.

X-ray pictures taken March 8 showed a fracture in the region of the symphysis of the mandible, and bilateral fracture of the neck of the condyles. On the left, the condyle was medially displaced and dislocated, and there was considerable overriding of the fragments. On the right, there was a fragment of bone lying medially from the neck of the ramus. (Fig. 51.) It could, it was felt, represent the head of the right condyle, since it was not seen in its normal position. X-ray pictures of the chest were interpreted as revealing a resolving infarct of the right costophrenic angle.

Under local anesthesia, March 14, bilateral superficial femoral vein ligation was performed by the surgical staff, while the dental team, at the same time, applied rubber-band traction to the lower jaw in an oblique fashion so as to draw the mandible forward and into occlusion in order to correct the displacement at the symphysis, where considerable callus had already formed. The occlusion was satisfactory March 20, when the rubber bands were changed.

The patient was seen in consultation with the anesthesia department, and it was the general opinion that, since she had been anesthetized with ether repeatedly, there would be less probability of postoperative vomiting if an

open reduction of the fracture dislocation of the condyle on the left was performed under pentothal sodium intravenous anesthesia. Oblique holes were drilled in the condylar fragments, through which a wire was passed (Fig. 52), finally being twisted together after impacting the fragments and reducing the dislocation. Sulfanilamide powder was dusted into the wound and the subcutaneous tissue was closed with catgut sutures and the skin with subcuticular suture.

The dressing was changed and the drain removed the next day. March 30, the patient again received a 500-cc. transfusion of whole blood. April 5, she was comfortable. The suture was removed April 6. The lateral postoperative x-ray view is shown in Figure 53; the anteroposterior view, in Figure 54.

The operation on the right side was undertaken April 7 under pentothal sodium anesthesia. An open reduction of the right condylar fracture was attempted. The zygomatic arch was located and the glenoid fossa opened by incision of the capsule of the joint. The condyle was nowhere near the articular fossa. After the ramus had been pulled down, the condyle was finally located at the inner surface of the ramus below the mandibular notch. It had attached itself to the bone in this location. When detached, it was found to be comminuted and broken in three pieces. As it was believed that there was little hope of obtaining a good result by retaining the condyle, it was removed. The stump of the ramus was made smooth with rongeur and bone files. (Fig. 54.) After this operation, the patient's heart rhythm was grossly irregular and suggestive of fibrillation, but the blood pressure was constant. Quinidine sulfate, 6 grains, was given.

Postoperative x-ray examination of the jaws April 11 showed that the left condyle was in good position and the right condyle had been removed. (Fig. 54.)

Quinidine sulfate was discontinued April 13, when the pulse rate remained regular at 90. The suture in the right condylar region was removed April 18. Slight tenderness was present in this area, though the incision was healing normally. The wires and elastics were removed from the teeth April 22, and the patient was advised to exercise the temporomandibular joint, but not to eat hard foods. Oral hygiene and toothbrushing were advised. The function of the facial nerve, tested May 18, was found to be normal on both sides.

The patient got up June 2 for the first time. Physiotherapy for rehabilitation was started June 7. The patient walked for the first time June 12 with the aid of a walker and crutches. Progress was slow, but she was discharged from the hospital June 30 with satisfactory results from all procedures. When she was seen in August, mandibular function was as good as could be expected. There was no complaint of pain or tenderness. September 21, the patient stated that she could eat without pain in the joint.

### IMMOBILIZATION OF THE MANDIBLE

All types of condylar fracture require immobilization of the jaws, whether treated by conservative methods, internal wiring or skeletal fixa-

tion. Interosseous wiring of the fractured condyle is not sufficient to effect healing, and motion in the fracture line is the main reason that wiring of the jaw has been found unsatisfactory in the past.

The best procedure employs Jelenko splints (Figs. 42 and 43) or Stout's continuous wiring (Fig. 12), attached to the teeth before the operation, and brings the teeth into as good occlusion as possible by traction. The function of these elastics during and after the operation was described above. When the time comes to mobilize the jaw for functional treatment of the joint, which should be done in cases with fracture dislocation as soon as the condylar fracture has healed sufficiently, the number of the elastics can be decreased gradually, so that more and more motion is possible. If the mandibular fracture has not healed sufficiently or the union is not strong enough, skeletal fixation can be applied under local anesthesia to the fractured bone at the time that functional treatment is started. Functional treatment is of great importance in fracture dislocation, since immobilization tends to produce regressive changes in the joint and, finally, ankylosis.

Bandages should be avoided whenever possible because they tend to press the angles of the jaw inward, and produce pressure posteriorly and upward, which is undesirable, especially in fracture dislocation, as a similar force caused the injury in the first place.

In edentulous cases, splints should be inserted as soon as possible to retain the distance between the jaws; or dentures may be used (Fig. 23). If teeth are present in the mandible, a maxillary denture may be locked to the mandible by stainless steel wires inserted in the bony piriform aperture of the nose, and fastened to an arch wire attached to the mandibular teeth (Fig. 55), as described by Thoma (1943).[45] If this is not possible, a Barton bandage reinforced by elastics will be necessary to hold the splints in place. If there are fractures in the remainder of the mandible, skeletal fixation should be applied (Figs. 21 and 25), to prevent displacement from the pressure of the bandage. A very good method of immobilizing the mandible was described by Waldron,[22] who used a Kirschner wire drilled through the symphysis. The mandible is held in position by means of forward and upward rubber-band traction applied from a head appliance and U-shaped wire. Another method accomplishing the same thing consists of placing half pins in the mandible, one on each side of the chin if possible, and fastening them to a headgear (Fig. 35), or by inserting half pins in the malar bones and connecting them to a skeletal appliance attached to the mandible, as described by Thoma (1944).[46] The last methods described will not only prevent the patient from moving the jaw, but also will do it without the use of a denture splint, so that wounds in the mouth are freely accessible. Also, there is no interference with vomiting or with a liquid diet.

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SUMMARY

1. Of thirty-two condylar fractures reported, five were bilateral and 22 unilateral. In sixteen cases, other mandibular fractures were present.

2. Of these thirty-two fractures, three were incomplete or showed no displacement. In eleven, there was overriding with displacement of the condylar fragment; twenty-two presented dislocation of various types, and three were old fractures with deformity such as pseudarthrosis or ankylosis.

3. In the treatment of these fractures, it was pointed out that the conclusions reached after careful checking of the end-results were not in accord with the contention of most writers on this subject that the methods in vogue are invariably successful. Contrarily, both major functional disturbances and minor complaints, such as pain, limited motion and malocclusion, are quite commonly found to be the result of conservative treatment.

4. It was pointed out that, in children, spontaneous readjustment of the mandibular joint, epiphyseal growth of the condyle and positioning of the teeth will, in time, greatly aid in the correction of minor defects that are present after treatment, but that, in adults, better results can be obtained by operative procedures.

5. A method for open reduction with internal wiring fixation was advocated for cases in which there is wide separation of the fragments disposing to nonunion, or marked overriding and displacement of the condyle that would result in shortening of the ramus and open-bite.

6. Another method of reduction of fracture dislocation involves immobilization of the condyle by skeletal fixation.

7. Functional treatment should be instituted to reestablish normal use of the joint even before fractures in the horizontal rami have healed.

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*Sulfonamides in Nerve Surgery—Regeneration.*—The use of the sulfonamide compounds in experimental wounds produced an increased amount of adhesions which fixed the nerve to the surrounding tissue. The adhesions were thicker and more extensive about the grafts, particularly the homogenous grafts. The use of the sulfonamide drugs was accompanied by an increased mesodermal proliferation at the suture line and at the same time led to a more intense neurotization of the scar tissue in the suture line. This was in addition to the moderate epineural and perineural reaction produced by the trauma of the suture. In general, it may be said that sulfadiazine provoked the most marked mesodermal reaction, perhaps because of retarded absorption, although the findings were in no instance those of a lasting chronic perineuritic inflammation. No conclusive evidence was found that the regeneration of nerve fibers, axis cylinder formation, myelinization, or the absorption of myelin decomposition products was changed by the use of sulfonamide drugs. The deviation and abnormal distribution of regenerating nerve fibers were observed regardless of whether a strong mesodermal suture reaction or an epineural reaction was traumatic, infectious, or was caused by the irritation of the sulfonamide drugs. The sulfonamide drugs did not interfere with the neurotization of an autogenous or homogenous graft, or the distal segment. However, in the homogenous graft series, a heteromorphous neurotization of the graft was found in all of the sulfonamide treated animals, whereas similar grafts in untreated animals showed in all instances some degree of isomorphous neurotization. —Davis *et al.,* in *Surg., Gynec. & Obst.,* September 1944.

# THE SULFONAMIDES IN ORAL MEDICINE

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IN recent years, an endless number of contributions have been made to the literature on the therapeutic administration of the sulfonamide compounds, but few have been written from the standpoint of, or with definite application to, oral medicine. This is unfortunate, particularly since the sulfonamides play so important a rôle in the treatment of oral sepsis, innumerable diseases and infections of the jaws, neck and face having been successfully treated and a still greater number prevented.

Much has been said in regard to the use of the sulfonamide compounds since the medical profession interested itself in their therapeutic potentialities about seven years ago. Since that time, the number of compounds comprising the group has steadily grown, there now having been synthesized nearly 1,400 new compounds, all derived from the parent sulfanilamide molecule. If allied compounds and undisclosed sulfanilamide derivatives were included, the probability is great that more than 3,000 new compounds would be available for chemotherapeutic study.

Since the sulfonamide drugs are remarkably effective against the bacteria most commonly identified with oral sepsis, namely the alpha hemolytic streptococcus *(Streptococcus viridans),* nonhemolytic streptococcus (gamma streptococcus), *Staphylococcus aureus* and *albus* and the anaerobes *Borrelia vincenti* and *Bacillus fusiformis,* they play a very important rôle in the therapy of the acute alveolar abscess, cellulitis, acute osteomyelitis, potentially dangerous infections of the floor of the mouth, the submaxillary space and along the fascial planes of the face and neck and general sepsis of oral origin. Clinically, the three sulfonamides most commonly used in oral medicine are sulfanilamide, sulfathiazole and sulfadiazine. This discussion will be limited, therefore, to these three compounds, and their respective therapeutic values and toxic reactions will be determined.

## MODE OF ACTION

The sulfonamides render "the blood, spinal fluid, urine and other tissue fluids unfavorable as a medium for supporting the active multiplication of susceptible bacteria," and "in consequence, tissue invasion by these organisms may be prevented, the production of toxic substances reduced, and the antibacterial immune mechanisms of the host permitted to complete the recovery from infection."[1] While definite information is lacking regarding the method of action of the sulfonamides, some investigators maintain that they act indirectly on bacteria. They believe that the de-

*Captain (DC) AUS.

fense forces of the body, having been enhanced by drug action, promote phagocytosis. Other investigators assert that the drugs act directly on bacteria, designating the compounds as bacteriostatic. This latter viewpoint, now the more generally accepted, assumes that bacteriostasis results from actual interference with the utilization of para-aminobenzoic acid, an essential constituent for bacterial growth.

No two patients react to the sulfonamides in exactly the same way. Probably, this is because some patients require larger doses to assure the desired concentration, or the same patient may even require different amounts at different times. This, which is due to the differences in absorption in individual patients, explains why sometimes an infection fails to respond to administration of one of the compounds, even though indicated.

A belief held by many general surgeons and oral surgeons is that when a sulfonamide is being administered to a patient, all other medication is contraindicated. This is not so. Neither are there harmful effects from simultaneous administration of other drugs and a sulfonamide; nor is there any reason for not administering sedatives or even hypnotics during sulfonamide therapy. Another belief still professed by some is that anesthesia should be avoided if at all possible during sulfa therapy. This likewise may be discredited, any type of anesthesia being permissible during actual administration. Regarding local anesthesia, Woods[2] found that certain substances could exert a reversible action on sulfonamide activity, and relatively large amounts of sulfanilamide could be rendered ineffective by the administration of these substances. Procaine, which is among these, is highly potent in its action *in vivo*. The use of large amounts of procaine in local anesthesia should be avoided in sulfonamide treatment, especially early in disease and more particularly in cases not receiving intensive treatment. Woods advises that substances not allied to para-aminobenzoic acid, such as cocaine and pontocaine hydrochloride, be used instead of allied substances such as procaine.

It is not necessary to eliminate sulfur-containing foods from the diets of patients receiving a sulfonamide.[3] In fact, the patient receiving a sulfa compound should receive a well-balanced diet. The only reasonable reservations that should be made are, first, that magnesium sulfate should not be given as a carthartic during administration of a sulfonamide, to avoid a possible sulfhemoglobinemia and, secondly, that ultraviolet therapy be avoided in order to prevent photosensitization. For the same reason, the patient, if ambulatory, should be cautioned against long exposure to sunlight. The beneficial effects of x-ray therapy are inhibited by the sulfa therapy and therefore the two should not be utilized simultaneously.

### CHOICE OF COMPOUNDS

The sulfonamide compounds have a considerable degree of specificity

in their antibacterial action against various species of micro-organisms. Accordingly, the specific sulfonamide must be used for the specific disease. General criteria for selection are: (1) the bacteria involved, (2) the region of the infection and (3) a history of previous sensitivity to sulfa drugs.

Generally speaking, in severe oral infections sulfanilamide has proved

TABLE 1.—COMPARATIVE TOXIC REACTIONS TO SULFONAMIDE THERAPY

| Manifestation | Sulfanilamide | Sulfathiazole | Sulfadiazine | Clinical Significance | Procedure |
|---|---|---|---|---|---|
| Cyanosis | xxx* | x | x | Not serious | |
| Nausea | xxx | xx | xx | Usually not serious | If serious, discontinue |
| Vomiting | xxx | xx | xx | Usually not serious | If serious, discontinue |
| Vertigo | xxx | x | x | Not serious | |
| Headache | xxx | x | xx | Not serious | |
| Conjunctivitis | | xx | xx | Usually not serious | If serious, modify dosage |
| Scleritis | | xx | xx | Usually not serious | If serious, discontinue |
| Dermatitis | xx | xx | x | Usually not serious | If serious, modify dosage |
| Acidosis | xx | | | Usually not serious | Administer alkali |
| Stomatitis | | xx | x | Usually not serious | If severe, modify dosage |
| Drug fever | xxx | xxx | xx | Usually not serious | If severe, modify dosage |
| Anemia (moderate) | xxx | xx | xx | Not serious | If persistent, give transfusion |
| Anemia (acute hemolytic) | xx | x | x | Dangerous | Discontinue therapy |
| Weakness | xxx | xxx | xx | Not serious | |
| Insomnia | xx | xx | x | Not serious | Give sedative or, if severe, hypnotics |
| Nervousness | xx | xx | xx | Not serious | |
| Chilliness | xx | x | xx | Usually not serious | If severe, modify dosage |
| Backache | xx | x | x | Not serious | |
| Palpitation | xx | xx | x | Usually not serious | If severe, modify dosage |
| Pruritus | xx | xx | x | Not serious | |
| Oliguria | x | xx | x | Dangerous | Discontinue therapy |
| Anuria | x | xx | x | Dangerous | Discontinue therapy |
| Hematuria (microscopic) | x | x | x | Usually not dangerous | Modify dosage and observe closely |
| Hematuria (gross) | xx | xx | x | Dangerous | Discontinue therapy |
| Crystalluria | x | x | x | Usually not serious | Modify dosage and observe closely |
| Renal colic | x | xx | x | Dangerous | Discontinue therapy |

*xxx, common; xx, occasional; x, rare.

most efficacious. This is explained by the predominance of streptococci present in infections in the oral field. Sulfadiazine may also be used to good advantage in streptococcic infections, but I prefer sulfanilamide in severe cases since its action is much more prompt, despite the possibly greater toxicity. There is a better understanding of the pharmacology of sulfanilamide than of that of any of its derivatives.[5] In order, however,

to determine without prejudice the effectiveness of sulfadiazine in severe infections as compared with sulfanilamide, I treated ten cases of diffuse cellulitis with the former. All but one of these cases were postoperative and, to judge from the appearance of the tissues, considerable trauma had been caused during the surgical procedures. In seven of the cases treated, the infection progressed despite sulfadiazine administration in adequate dosage for periods of from two to four days before any appreciable subsidence was visible. The progress of the disease, although impaired, was not arrested so quickly as it might have been. In the three other cases, the infection became more diffuse until, on the fourth day of therapy in each case, in an effort to prevent a fatality, sulfadiazine was withdrawn and sulfanilamide was given in its place. Two of the patients showed marked

TABLE 2.—AVERAGE DOSAGES OF SULFANILAMIDE, SULFATHIAZOLE AND SULFADIAZINE

| | Weight of Patient | | Initial Dosage (Grains) | | | Maintenance Dose (Grains) | | |
|---|---|---|---|---|---|---|---|---|
| | Pounds | Kilograms | Sulfanilamide | Sulfathiazole | Sulfadiazine | Sulfanilamide* | Sulfathiazole* | Sulfadiazine† |
| Severe infections | 50 | 23 | 50 | 50 | 50 | 10–12 | 10 | 12½ |
| | 75 | 34.5 | 55 | 55 | 55 | 12–15 | 12 | 15 |
| | 100 | 45 | 60 | 60 | 60 | 15–22½ | 15 | 22½ |
| | 125 | 57.5 | 65 | 65 | 65 | 17–20 | 17 | 20 |
| | 150 | 70 | 80 | 80 | 80 | 20–22½ | 20 | 22½ |
| Mild infections | 50 | 23 | 10 | 10 | 10 | 10 | 10 | 15 |
| | 75 | 34.5 | 10 | 10 | 10 | 10 | 10 | 15 |
| | 100 | 45 | 15 | 15 | 15 | 15 | 15 | 22½ |
| | 125 | 57.5 | 15 | 15 | 15 | 15 | 15 | 22½ |
| | 150 | 70 | 20 | 20 | 20 | 20 | 20 | 20 |

*Every four hours. †Every six hours.

improvement within a few hours after substitution and the patients progressed toward uneventful recoveries. The third patient, whose temperature was 101.5, pulse 104 and respiration 28 at the time sulfadiazine therapy was begun and temperature 103.8, pulse 136 and respiration 38 when sulfanilamide was employed, remained in a critical condition for thirty-six hours, after which there was a very slow recovery. Because of the patient's inability to take liquids and prescribed nourishment at proper intervals, 1,500 cc. of 5 per cent glucose solution was given by hypodermoclysis each of the four days preceding subsidence of the fulminating symptoms. During this period, the sulfanilamide was administered parenterally. I do not hesitate to state that if sulfanilamide had not been substituted for sulfadiazine, the patient would not have recovered from the infection. Furthermore, I feel that the length of the recovery period, even after sulfanilamide was em-

ployed, was due only to the fact that a sulfa tolerance had been created by the four days of sulfadiazine therapy. I believe that the efficacy of sulfanilamide against such pathogens as are usually found to infect surgical or traumatic wounds is well established.

Sulfathiazole is indicated in the treatment of staphylococcic infections, but has little practical advantage over sulfadiazine, which is indicated for either streptococcal or staphylococcal infections. Although sulfadiazine is less bacteriostatic, the slight difference is probably offset by the fact that after use of sulfadiazine, the blood and tissue levels are higher and more nearly uniform than is the case with sulfathiazole. I do prefer sulfathiazole, however, for prophylaxis against bacterial endocarditis and in the treatment of acute osteomyelitis.

Since many of the infections with which we come in contact are of a mixed type or a type in which the organism cannot be determined, the value of sulfadiazine must be appreciated.

In the treatment of acute osteomyelitis of the jaws, I have obtained favorable results with sulfathiazole in the majority of cases. Suppuration was reduced in some cases within twenty-four hours and, in most cases, within seventy-two hours after treatment was initiated. In hematogenous osteomyelitis, there have been fewer instances of massive bone necrosis when sulfathiazole has been employed. I have seen a few cases of acute osteomyelitis that evidently were not benefited by sulfa therapy and, from available evidence, it seems that penicillin will largely replace the sulfonamide compounds in the treatment of acute osteomyelitis. In chronic osteomyelitis, use of the sulfa drugs has not in my experience proved to be of any apparent value.

TABLE 3.—AVERAGE DOSES FOR CHILDREN PER KILOGRAM OF BODY WEIGHT

| | Initial Dose (Gm.) | Maintenance Dose |
|---|---|---|
| Sulfanilamide | 0.1—0.15 | 1/6 initial dose every 4 hours |
| Sulfathiazole | 0.15 | 1/6 initial dose every 4 hours |
| Sulfadiazine | 0.1—0.15 | 1/4 initial dose every 6 hours |

In the treatment of acute pericoronal infection of submerged or partially erupted teeth, prophylactic doses of sulfadiazine are extremely beneficial. This therapy should, of course, be supplemented by hot irrigations with a physiologic solution of sodium chloride locally. It is assumed, of course, that drainage will be established when necessary.

Successful treatment of extensive actinomycosis with sulfanilamide and with sulfadiazine has been reported. A very obstinate case was treated by 1-gm. doses of sulfadiazine given every four hours for one week and then four times a day until the drug had been continuously administered for

121 days.[6] The patient showed no ill effects from this prolonged administration and the condition cleared up completely. A very severe case of actinomycosis affecting the jaws was successfully treated with sulfanilamide.[7]

### TOXIC REACTIONS

It must be borne in mind that the sulfonamides not only have toxic effects on the invading bacterial cells to be destroyed, but also have the same effect on the body cells. Approximately 70 per cent of the patients receiving sulfadiazine and about 40 per cent of those receiving sulfathiazole show no apparent toxicity, whereas only about 10 per cent of those receiving sulfanilamide are free from visible effects. Many of the reactions are temporary and should not cause alarm.

I shall list some the more common reactions to the beginning of therapy, with the hope that when they do occur, sufficient consideration will be given

TABLE 4.—DATA ON VINCENT'S INFECTION

| Number of Cases | Therapy | Subsidence of Acute Symptoms | Complete Elimination of Disease |
|---|---|---|---|
| 20 | (Control cases) Vitamin therapy only | Average, 4th day<br>Shortest, 2nd day<br>Longest, 6th day | Average, 18th day<br>Shortest, 14th day<br>Longest, 26th day |
| 19 | Sulfathiazole and vitamin therapy | Average, 3rd day<br>Shortest, 2nd day<br>Longest, 5th day | Average, 19th day<br>Shortest, 13th day<br>Longest, 26th day |
| 19 | Sulfadiazine and vitamin therapy | Average, 3rd day<br>Shortest, 2nd day<br>Longest, 5th day | Average, 18th day<br>Shortest, 14th day<br>Longest, 25th day |

the situation before the drug is withdrawn. A knowledge of the various reactions to administration of the drugs is essential.

Most patients receiving sulfanilamide show considerable cyanosis of the skin and mucous membranes. This is due ordinarily to methemoglobinemia or, occasionally, sulfhemoglobinemia, and usually occurs early in the treatment. Cyanosis is seldom seen in sulfathiazole or sulfadiazine administration. Acidosis occurs occasionally under sulfanilamide—never under sulfathiazole or sulfadiazine therapy. For this reason, some authorities assert that sodium bicarbonate should be given in equal dosage with a sulfonamide. I believe that one-half the amount is sufficient and that it need be given only when there are indications of acidosis.

Administration of any of the three drugs may result in nausea, vomiting, headache, vertigo, diarrhea or tinnitus. These conditions, according to Spink,[8] may be due to a nervous system reaction rather than to local conditions. For any of these conditions, the patient should be kept under seda-

tion and in bed. The administration of 1 dram of sodium bicarbonate will often check nausea.

Sulfathiazole administration often causes a rash, with or without fever. It may cause all kinds of rashes, urticarial or nodular rashes having been seen as early as thirty-six hours after therapy was instituted. Mild to severe forms of arthralgia may accompany fever and rash.

Stomatitis, scleritis and conjunctivitis have occurred with sulfathiazole, but not with sulfanilamide or sulfadiazine therapy. The injection of the sclera and conjunctiva gives an appearance of "pink-eye" in severe cases. The stomatitis, of the herpetic type, may be either localized or generalized.

TABLE 5.—DATA ON VINCENT'S ANGINA

| | Therapy | Subsidence of Acute Symptoms | Complete Elimination of Disease |
|---|---|---|---|
| Case 1 | Vitamin therapy and arsenical* | 2nd day | 12th day |
| Case 3 | Vitamin therapy and arsenical* | 2nd day | 10th day |
| Case 7 | Vitamin therapy and arsenical* | 2nd day | 13th day |
| Case 9 | Vitamin therapy and arsenical* | 2nd day | 13th day |
| Case 2 | Sulfathiazole and vitamin therapy | 4th day | 22nd day |
| Case 5 | Sulfathiazole and vitamin therapy | 6th day | 25th day |
| Case 8 | Sulfathiazole and vitamin therapy | 4th day | 18th day |
| Case 4 | Sulfadiazine and vitamin therapy | 4th day | 19th day |
| Case 6 | Sulfadiazine and vitamin therapy | 4th day | 23rd day |
| Case 10 | Sulfadiazine and vitamin therapy | 5th day | 22nd day |

*Intravenously.

Small papules form on the tongue, cheeks, lips and palate or, very rarely, on the gingivae. Ulcer formation follows the eruption, and coalescence of the ulcers results. Since the tissues return to normal without treatment within a few days after discontinuance of the sulfonamide, local treatment is not desirable.

Microscopic examination of the urine may reveal hematuria or crystalluria during sulfonamide therapy with any of the compounds, particularly if administration has been continued for a considerable length of time. Because of possible renal complications during sulfonamide therapy, the urinary output should exceed 1,200 cc. every twenty-four hours during

treatment. This necessitates a fluid intake of not less than 3,000 cc. in each twenty-four hour period. Renal crystalluria may result in death or chronic invalidism.[9] A renal reaction due to precipitation in the urinary tract is now recognized as one of the most frequent and serious complications of sulfadiazine therapy. With proper supervision, however, such a complication can be recognized early and corrective measures can be taken. Gross hematuria, renal colic, oliguria or anuria rarely becomes evident, particularly in sulfathiazole therapy. The occurrence of any of the latter conditions necessitates immediate discontinuance of chemotherapy.[10]

In anemia, we have a definitely more serious toxic effect of treatment with the sulfonamides. It is for this reason that frequent blood examinations are of paramount importance during therapy. A simple and accurate method of determining the blood level, requiring only a drop of blood from the finger tip, has been described by Peters.[11]

A moderate anemia commonly occurs during sulfanilamide therapy and occasionally during sulfathiazole and sulfadiazine administration. This type of anemia is not serious and does not necessitate withdrawal of the drug, but the blood picture must be watched closely. In fact, if the anemia slowly progresses, but therapy is indispensable, transfusions may be given as therapy progresses. If acute hemolytic anemia develops, immediate discontinuance of the sulfonamide must be effected, and large amounts of alkali must be administered and blood transfusions given. Acute hemolytic anemia, although comparatively rare in sulfa therapy, is probably the most serious single toxic reaction possible from sulfonamide administration.

Leukopenia, which occasionally develops after prolonged administration, is important since it may be a precursor of agranulocytosis, a dangerous complication. The condition calls for immediate discontinuance of therapy.

## CELLULITIS

Cellulitis of the face, neck or floor of the mouth and adjacent structures is one of the more common infections seen by the oral surgeon. It is a potentially dangerous inflammation of the cellular or connective tissues resulting usually from infection of a tooth or socket or, not infrequently, from traumatic injury, surgical or accidental. No treatment can compare with the chemotherapy of the sulfonamide compounds in the treatment of cellulitis. The results obtainable by the administration of either sulfanilamide or sulfadiazine are excellent in ordinary cases. Many cases of severe cellulitis that otherwise might have ended fatally were, I believe, aborted only through the use of the sulfonamides. Fulminating cases have been aborted within a few hours after sulfatherapy was instituted.

As to the choice of sulfonamides in the treatment of severe cases of cellulitis, I prefer sulfanilamide, as previously mentioned. Although both afford excellent results and, although the evident toxic reactions are mini-

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mized in the average case with sulfadiazine, the infection is much more quickly controlled by sulfanilamide, and general debilitation of the patient is prevented. Sulfadiazine does not "knock" the infection as sulfanilamide does; consequently, administration is prolonged. In extreme cases of cellulitis, it is sometimes impossible to determine the exact type of infection, and hence, if no improvement is evident within thirty-six hours' therapy with sulfanilamide, sulfadiazine should be substituted to combat the probably predominant staphylococcus.

### DOSAGE

When a severe infection is evident, sulfonamide therapy should be instituted immediately. The drug must be given in dosage adequate for effective blood concentration. Insufficient dosage at the onset often gives the infection too great a start and produces a tolerance to the drug, which results in a need for larger doses subsequently. Furthermore, administration must be continued for a longer period if the dosage at first is not sufficient. Inadequate dosage is a common failing in sulfonamide therapy.

Effective blood levels that must be established in the treatment of severe infections are considered to be: for sulfanilamide, 10-15 mg. per hundred cubic centimeters; for sulfathiazole, 4-10 mg., and for sulfadiazine, 8-15 mg. This means that an initial dose for an adult patient (one over 14 years of age) of 50-90 grains must be given, the amount depending on the weight of the patient. This is followed by smaller doses of 10-22½ grains every four to six hours day and night. Four-hour intervals for sulfanilamide and sulfathiazole or six-hour intervals for sulfadiazine will ordinarily maintain the proper blood concentration. The primary object of systemic administration is to produce and maintain in the tissue fluids, and more specifically at the site of the infection, a therapeutically effective concentration of the sulfonamide.

The dosage of a sulfonamide drug is the same in all diseases, but varies according to the weight of the patient, the severity of the infection and the individual differences in absorption. The first two of these points may be used initially to determine the dosage in every case. The absorbability must be determined by observation of the patient, and the dosage can then be altered to assure the desired effect.

In severe infections in children and infants, it is necessary to maintain the same blood level as for adults. The twenty-four-hour dose should be based on 1½ to 2 grains per pound of body weight. This amount should be determined and then given in four to six equally divided doses over the twenty-four-hour period. For small children or infants, the tablets should be crushed in a small glass of water.

In a severe infection, the dosage should be continued for at least seventy-two hours after the temperature returns to normal, to prevent a secondary

flare-up, which may occur if the drug is withdrawn too soon, since the bacteria that have been retarded may regain their invasive power when therapy is discontinued. Since bacteria may acquire a sulfonamide tolerance, the dosage should not be tapered off, but rather maintained in full amount until discontinued. Drug-resistant bacterial strains develop when the organisms are exposed to sublethal concentrations of a sulfonamide for some time. This is an important observation from the standpoint of possible dissemination of drug-resistant strains by carriers.

Experience indicates that the sulfonamide drugs are best administered by the oral route. If use of this route is not practicable, the drugs may be given parenterally or, with the exception of sulfathiazole, rectally by retention enemas. In parenteral administration, the method of choice employs a freshly prepared 1 per cent solution in physiologic sodium chloride subcutaneously. Although an aqueous solution may be given intramuscularly, I have never had the necessity for intramuscular administration. The dosage is the same in any of these methods as in oral administration.

## VINCENT'S INFECTION

Vincent's infection, an ulceromembranous inflammation of the mucous membranes, may affect several of the body cavities. It may produce lesions in the ear or on the genitalia just as in the mouth. I do not believe that the disease is contagious in the usual sense of the word or that isolation is ordinarily required. The victim must have a predisposition to the infection, such as lowered tissue resistance through general debilitation or reduction of tissue tone due to trauma or poor hygiene. The lesions may appear on any of the mucous membranes in the body. The frequent appearance of them on the oral, nasopharyngeal or laryngeal tissues does not preclude their occurrence along the folds of the mucous membranes of the female genitalia and, via the vagina, the endometrium, or on the glans penis.

My treatment depends on the severity of the infection. If symptoms of systemic infection exist, the patient should be treated as for any systemic infection. Escharotic drugs have no place in the rational treatment of the local lesions in ordinary cases. The use of these caustics further damages tissue already struggling for life. The concentrated intake of ascorbic acid, niacin and riboflavin effects marked improvement in the tissues, with disappearance of the lesions in a surprisingly short time. The general diet must be balanced and deficiencies in absorption of certain substances should be supplied by proper therapy. My chief treatment of the local lesions is observation, with a hands-off policy. In very severe cases, the ulcers may be dusted with arsphenamine powder and the general treatment enlarged to include intravenous injections of arsphenamine.

With increasing reports[12] that the sulfonamides were effective in combating the disease, I treated a series of thirty-eight cases of Vincent's infec-

tion and six cases of Vincent's angina with the compounds. I might mention that the cases of Vincent's infection, as the twenty control cases, were all clinically diagnosable. Only cases showing definite ulceration or sloughing were used. Sulfathiazole was used in half the cases and sulfadiazine in the other half. The results, recorded in Table 4, indicate that the acute symptoms subsided about twenty-four hours sooner in the average case. There was no notable difference in results in the cases treated with sulfathiazole from those in the cases treated with sulfadiazine.

Vitamin therapy was utilized in every case, but the arsenicals were administered only in those cases of the angina type not receiving a sulfonamide. Although the acute symptoms subsided more rapidly in the sulfa-treated cases, the time required to effect a complete cure was not shortened. The angina cases treated with sulfonamides required more than twice as much time to show any subsidence as those treated with an arsenical did. The intravenous administration of arsphenamine had the usual prompt results in the control of the disease and shortened the course of the infection considerably.

Sulfonamide consideration need only be given, therefore, in cases of Vincent's infection, since the only benefit was evidenced in these cases; i.e., the twenty-four hour shortening of time in the reduction of the acute lesions. As this advantage is outweighed by the possible toxic reactions, I conclude that the sulfonamides, in the light of present knowledge, are not appreciably beneficial in the treatment of Vincent's infection.

### LOCAL USE

It has become a widespread practice to utilize sulfanilamide or a derivative in powder or crystal form in open wounds. Dentally, the principle has been applied to extraction sockets. In my opinion, the practice should be discouraged because clinical statistics have proved that instead of being beneficial, local application to bony sockets is actually detrimental to healing in the great majority of cases. Instead of benefit from topical application of the drug, there is many times an actual increase in local irritation and the pain is intensified. Krashen,[12] in his study on the action of sulfonamides, concludes that sulfanilamide acts as a foreign body when applied locally and consequently such application interferes with normal blood-clot formation.

Many general surgeons are now using sulfonamide powder or crystals in wounds after operative procedures, and while many feel that post-operative infection occurs less frequently, few assert that it has no slowing effect on the healing process. In wounds with adequate tissue exposure, some assert that an effective local concentration is established and thus advocate a fine spray in traumatic wounds. I have used this method in facial wounds and in through-and-through incisions such as are encoun-

tered in radical jaw resections, but I doubt whether there was any actual benefit. I believe that the time required for epithelial regeneration was increased in every case. Bellows found that not only do the sulfonamides have an unfavorable effect on actively growing epithelium, but also the amount of scarring is increased.[13]

Two of the chief objections to local use are the local damage to tissue and the development of resistant strains of bacteria about the wound.

A few authors have reported successful local sulfonamide therapy in dry socket. How the drug is supposed to act in a socket devoid of a normal blood supply or with none at all is not clear to me. After extensive experimentation, I conclude that to place a sulfonamide in a bony socket is of no benefit at any time, but often is rather detrimental to healing.

## PROPHYLAXIS

More and more attention is being given to prevention of bacterial invasion of tissue by the prophylactic use of the compounds. The sulfonamides are used prophylactically to prevent relighting of a quiescent infection. That the prognosis of surgical interference is greatly improved by the prophylactic administration of the compounds is well exemplified in the removal of infected cysts.

Before one of the sulfonamides is administered prophylactically, it is advisable to evaluate the patient's sensitivity to the drug. By way of explanation, it might be said that this is important since many patients who are not seriously ill and do not have acute symptoms react toxically to administration of the sulfonamides; whereas, when they are sick, they may show no toxic reaction. To determine a patient's sensitivity, 5 grains is administered orally and the patient is observed for twelve hours. Any sensitivity will be evident within that time. This procedure should never be followed when the symptoms indicate acute infection.

Establishment of an effective preoperative blood level is indicated in patients with damaged heart valves. A patient with a history of, or whose clinical signs indicate, damage to the valves from rheumatic fever, syphilis or a congenital heart defect should be hospitalized for any operative procedure, including the extraction of teeth. An effective blood level should be established before the operation is performed and the therapy maintained for twenty-four to thirty-six hours postoperatively to prevent further cardiac damage, which otherwise might easily result from manipulative procedure.

We also must be mindful of the danger of possible complications from surgical procedures. In oral surgical operations, particularly, we must be mindful of bacteremia following the removal of diseased teeth. The procedure described above for treatment of patients with cardiac disease is successful in lowering the incidence and virulence of bacteremia following

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extraction. In patients with valvular disease, the possibility of ensuing subacute bacterial endocarditis is greatly diminished by prophylaxis with sulfathiazole.[14]

Bacteria liberated into the blood stream by the extraction of teeth may localize on a damaged heart valve and bacterial endocarditis result, unless the circulating blood is kept free of the bacteria.

In all cases wherein postoperative infection is regarded as a possibility, an attempt should be made to obtain a blood concentration of at least 60 mg. per liter at the time of operation. To obtain this concentration, 10 grains should be given every four hours for two days before operating. In the average case, I continue the same therapy for twenty-four hours postoperatively, at which time it is discontinued, unless there is even the slightest indication of infection. It is about forty-eight hours after commencing administration of a sulfonamide that the existing blood concentration of the drug is most potent against micro-organisms.

## CONCLUSION

The sulfonamides must not be accepted as capable of curing anything and everything. Their ability to act as miracle drugs has been dramatically exaggerated. There are innumerable conditions in which their benefit is questionable and many others in which they are of no benefit at all. They, as all other therapeutic agents, have their indications and should be prescribed or administered only when the indication is reasonably definite. They must be used with discretion. Thought and careful study of the existing symptoms must be given for correct diagnosis in every case so that the proper sulfonamide may be given at the onset and in an adequate amount. Sulfonamides are powerful and effective weapons in combating infection, but they are not self-sufficient. Adequate drainage by surgical intervention and the proper supportive measures must be instituted as soon as indicated. The source of the infection must be eliminated for successful treatment.

## SUMMARY

1. The sulfonamide compounds are among the most valuable chemotherapeutic agents available for the treatment of oral infections.

2. The toxic reactions occurring during sulfonamide therapy are not usually serious, but should be observed closely. Acute hemolytic anemia, gross hematuria, renal colic, oliguria and anuria are serious toxic reactions, calling for immediate discontinuance of therapy and antitoxic treatment.

3. The dosage of a sulfonamide is the same for all diseases, but varies according to the severity of the infection and to the weight of the patient. Modification due to individual differences in absorption and excretion may become necessary.

4. Administration by the oral route is preferable.

5. Inadequate dosage is one of the most common failings in sulfonamide therapy.

6. Local use has more untoward than happy results in oral medicine and surgery. Local application has no place in the treatment of alveolar sockets.

7. Whenever the prognosis is bad, prevention of bacterial tissue invasion should be effected by prophylactic administration of the sulfonamides.

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# CONGENITAL BONE ANOMALIES*

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WITHIN the mouth, abnormal growths of bone occur most commonly in the palate at the midline, lingually from the mandibular bicuspids, and, more rarely, buccally from them. These bony tumors appear clinically as smooth enlargements, often lobular in formation, and they grow either unilaterally or bilaterally.

Roentgenographically, they present increased radiopacity and are more dense and noncancellated in appearance than normal bone. They indicate an area of exostosis. Histologically, they show simple hypoplasia of bone.

Removal of these growths, termed torus palatinus or torus mandibularis

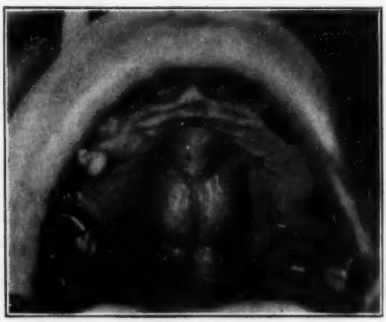

Fig. 1.—Torus palatinus (lobular).

according to their location, is usually advisable for one or more of the following reasons: (1) to facilitate prosthetic work; (2) to overcome a cancer phobia on the part of the patient; (3) to prevent interference with speech from impingement on the tongue; (4) to prevent the overlying soft tissues from being irritated and thinned out because of their size and position, and (5) to avoid packing of sticky foods into the interlobular spaces.

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Note: The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large. (Art. 113 [2] U. S. Navy Regulations.)



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### TECHNIC OF REMOVAL

Adequate anesthesia is obtained by blocking the nasopalatine and anterior palatine nerves.

If the growth is in the palate and but moderately large, an incision can be made in the midline (median raphe) to extend slightly beyond the ends of the growth. If the mass is from 7 to 10 mm. in height, a longer incision is necessary to permit elevation and retraction of mucoperiosteal flaps to expose the bony lump completely. Posteriorly, in the palate, one must use

Fig. 2.—Midline incision from rugae to junction of hard and soft palate.

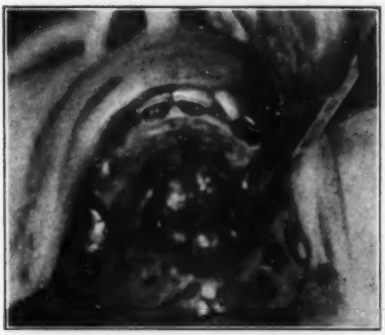

Fig. 3.—Flaps reflected for exposure of bony mass.

care not to incise posteriorly from the border of the hard palate into the velum. Lateral extensions of the incision should be avoided in order to conserve the blood supply of the flaps.

The bone can be removed either by a chisel and mallet or by means of grooves cut through it with a dental bur and, for this, a cross-cut fissure type is very useful. The irregular base is made smooth with rongeur forceps

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and with bone files. Obviously, the curvature of the palate should be kept in mind and care should be used not to perforate it.

## SUMMARY

With the aid of a histologic section, the patient will be reassured that the growth is benign. For section, a portion of bone large enough for decalcification is obtained at the time of operation.

By careful diagnosis, these bone anomalies can be differentiated from: (1) abscess of the palate of dental origin; (2) hypercementosis over the maxillary bicuspid; (3) mixed tumor of the palate; (4) gumma; (5)

Fig. 4.—Appearance of area after bone removal.

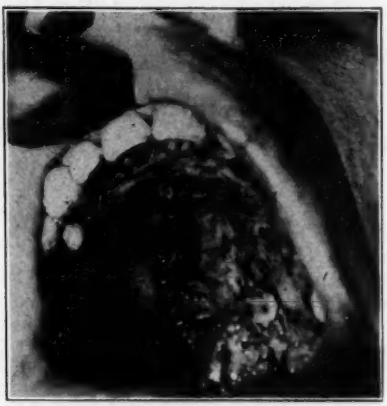

Fig. 5.—Flaps returned to position and approximated with mattress sutures.

follicular cyst; (6) fibroma; (7) osteoma, and (8) hypertrophy of the palatine glands.

Fig. 6.—Small torus palatinus (bifed type).

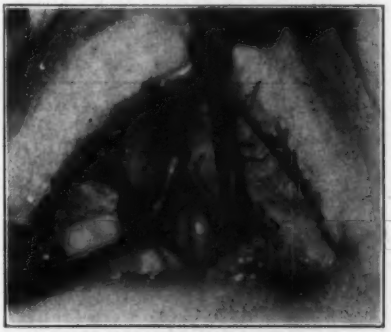

Fig. 7.—Midline incision for exposure.

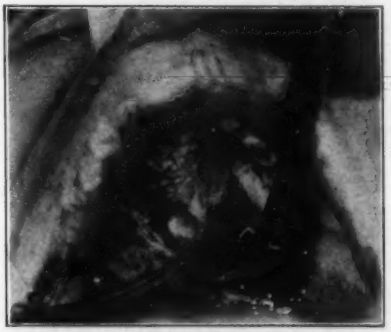

Fig. 8.—Appearance after bone removal.

Fig. 9.—Flaps returned to position and sutured.

Fig. 10.—Radiopacity in midline of palate due to increase in density of torus palatinus.

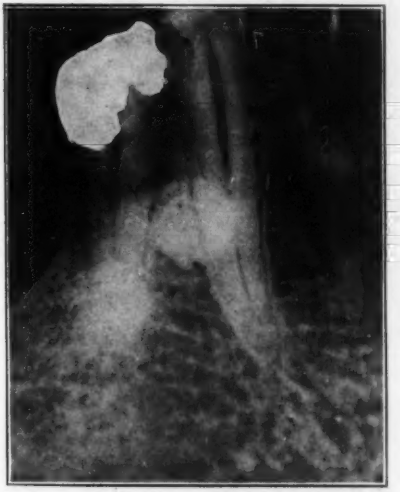

Fig. 11.—Two circumscribed areas of radiopacity due to presence of two lingual tori.

Fig. 12.—Decalcified histologic section showing dense laminated cortical bone. Evidence of osteogenic activity is slight. The spongiosa is normal.

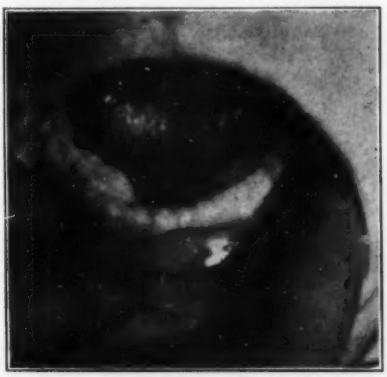

Fig. 13.—Tori mandibularis, removed to facilitate construction of mandibular denture.

Fig. 14.—Occlusal mirror view of tori mandibularis.

Fig. 15.—Bilateral exostosis of mandible (buccal).

Fig. 16.—Labial exostosis of maxillae.

Fig. 17.—Large lobular torus palatinus, which would interfere with prosthetic appliances.

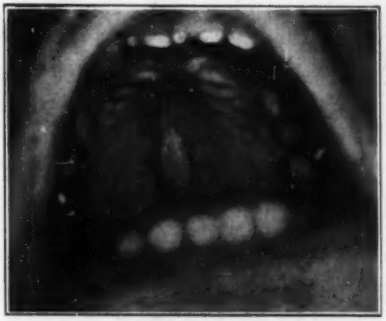

Fig. 18.—Small spindle-shaped torus palatinus.

Fig. 19.—Small bilateral torus near junction of hard and soft palate.

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Fig. 20.—Unilateral partial denture constructed so as not to interfere with medium size unilateral torus palatinus.

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*Tourniquets in Diagnosis of Incipient Shock.*—The need for a method that will aid in the detection of incipient traumatic shock has been repeatedly emphasized. The decline in blood volume which occurs in the early stages of traumatic shock is associated with vasoconstriction and a fall in cardiac output. Because of vasoconstriction, the arterial pressure usually does not decline until a later stage of shock has been reached. It is obvious, then, that it is desirable to diagnose early or incipient shock before the arterial pressure declines. The presence or absence of alterations in the pulse rate and in the concentration of the red blood corpuscles may be misleading. It is agreed by most workers in this field that one should treat shock according to the extent of injury and blood loss and the general clinical picture rather than wait for alterations in the blood pressure or pulse rate or concentration of the red corpuscles. A test for incipient shock, if it is to be of practical value, should be simple, rapid, and reliable. . . . The method is simple, but is not so rapid as might be desired. In a few cases, it has indicated incipient shock when it was present. The principle underlying the method is that of reducing temporarily the effective volume of circulating blood by trapping part of the blood in the lower extremities by the application of venous tourniquets. It was reasoned that in the presence of a previous reduction in blood volume, a further decline might not allow compensatory vasoconstriction to maintain the arterial pressure at the normal level.—Longmire *et al.*, in *Surg., Gynec. & Obst.*, October 1944.

# FRACTURE OF THE MANDIBLE ASSOCIATED WITH BURNS OF THE HEAD: REPORT OF CASE

T. W. KARNES,* D.D.S., San Francisco, Calif.

WITH increasing frequency, in both civilian and military hospitals, patients are seen on the surgical services with fractures of the facial bones together with burns of the head and face. The cooperation of the oral surgeon with the general surgical staff, as well as the problems involved in coordinating the different types of treatment necessary, is demonstrated by the following case report. Because of the type of injuries incurred in this case and the problems encountered in their treatment, certain modifications of accepted methods of stabilization were necessary and the construction of an intra-oral appliance for extra-oral traction upon the fractured mandible was found to be comfortable, simple to apply and effective.

Fig. 1.—Occlusal x-ray appearance of mandible, showing displacement of fractured parts.

## REPORT OF CASE

*History.*—A man, aged 21, was admitted to hospital one hour after an accident.

*Examination.*—There were third degree burns of the left scalp, forehead and temporal region, left ear, part of the left cheek and left upper and lower eyelid. There was also a fracture of the mandible (Fig. 1) between the left cuspid and first bicuspid, compounded both intra-orally and externally, with a laceration about 2 inches long over the externally compounded area. The right mandibular fragment was displaced lingually and downward and was impacted. There was also a comminuted fracture of the left elbow. No attempt was made at reduction of the fracture of the mandible at this time.

Further examination, at a later date, revealed the following intra-oral condition: The buccal half of the crowns of the right upper first bicuspid, right upper first molar and right lower second bicuspid, and the lingual half of the crowns of the left upper first bicuspid, left upper first molar, left lower second bicuspid and left lower second molar were fractured in a vertical plane

*Captain (DC) AUS.



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and were missing. The upper right and left third molars were malposed and only partially erupted. The lower third molars were erupted, but were not in occlusion with the opposing teeth. It was evident from this picture of fractured teeth that the exact former occlusion could not be attained and that a position approximating normal would have to be determined. It was evident that intermaxillary fixation would be difficult because these fractured and malposed teeth were not suitable for retention of wire loops. The use of a head cap for external traction and immobilization was obviously impossible because of the dressings over the burned areas of head and face.

*First Operation.*—Because of the patient's critical condition, brought on by shock and the extent of the area covered by third degree burns, it was eight days before reduction of the fracture of the mandible could be attempted. Under pentothal sodium anesthesia, the impacted fragments were loosened by manual manipulation and the mandible reduced to a position approximating what the former occlusal relationship was considered to have been. The left cuspid, which was lying in the line of fracture, was extracted. Intermaxillary stainless steel wires were placed about those teeth thought suitable for retention and

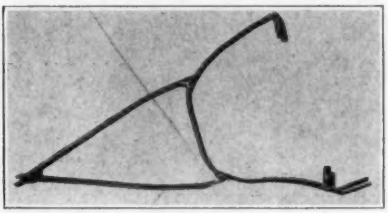

Fig. 2.—Upper labial arch bar appliance with extension arms for extra-oral traction.

the mandible was immobilized. It was noted, at this time, that the digastric, geniohyoid, genioglossus and other associated muscles of the floor of the mouth exerted considerable pull on the symphysis region, which tended to displace the right fragment distally. Because of the many fractured teeth, there was no longer a point of normal occlusion to help stabilize the fragments after reduction.

*Second Operation.*—Nine days after immobilization, the right fragment was noted to have slipped distally about 0.5 cm. The intermaxillary wires were removed and a modified Winter labial arch bar was placed from the right second molar to the left second molar. This arch was wired to the teeth of both fragments after reduction to the normal position and the arch bar was in turn wired to the upper teeth. This maintained stabilization for several days, but it was noted that a slow displacement lingually of the lower border of the right fragment was taking place. This created a depression of the chin on the right side.

During the time of treatment and fixation of the mandible, the patient had undergone a plastic operation to replace skin lost over the eye. A large pressure dressing over this area, together with dressings over the remaining burned areas of the scalp and ear, still prevented placing a plaster head cap for anterior traction to the mandible. It was then decided to build a heavy labial arch

for the upper jaw which had pins 2 inches long projecting from each cuspid region. The ends of the pins were bent to form a hook and soldered together. (Fig. 2.) In the molar region of the arch on both sides, a short pin was soldered and bent over the occlusal aspect of a suitable tooth to act as a rest and to prevent the appliances being displaced upward into the gingivae.

*Third Operation.*—This arch was then wired to the upper teeth. A labial arch was wired to the lower right fragment only, extending from the left lateral incisor to the right second molar.

The left lower first bicuspid was found to be loosened and partly in the line of fracture and was extracted. The teeth in the left lower fragment were then wired directly to the upper arch. A heavy rubber band was placed over the hook on the upper arch bar extension and attached to the lower right arch bar in such a position as to pull the fragment outward and somewhat to the right. (Figs. 3 and 4.) At this time, it was not possible manually to replace

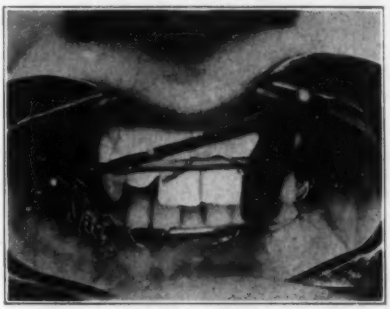

Fig. 3.—Appliance wired in place. Rubber band tension is exerted from the upper extension arms down to a short lower labial arch bar to give outward and lateral traction to the right fragment. The photograph, taken three days after the appliance was placed, shows reduction nearly complete.

the fragment forward in proper position as fibrous union of the parts was progressing.

Within thirty-six hours after the appliance was placed and the rubber band tension was established, the mandible was again in normal position, having been brought forward and to the right. The lower arch bar was then wired to the upper arch bar to assist in maintaining the position. The rubber band tension was reduced somewhat, but allowed to maintain a light constant pull forward to overcome the muscle pull lingually. This appliance remained in place for forty-six days after the accident, when satisfactory primary union of the fracture was found to be present and the arch bars were removed. The midline was in the correct plane and the occlusion, after replacement of the fractured teeth with bridgework, will be normal.

## COMMENT

An improvement in the appliance might be suggested to overcome some of the difficulty in taking food. The extension arms from the upper arch bar could, before soldering to the bar, be bent at a right angle about one-fourth

inch from the end and this end soldered to the lower edge of the bar. In the case reported here, the ends of the arms were left straight and soldered to the front of the bar. This not only kept the upper lip elevated at the corners, but also made it difficult for the patient to create suction in the mouth to draw

Fig. 4.—Profile view of patient with appliance and rubber bands in place. The chin scar and burns of ear and cheek are to be noted.

Fig. 5.—Appearance of mouth and occlusal relationship at completion of treatment.

fluids through a drinking tube. There was no irritation of the lips from the bar.

During the latter days of convalescence, and while the appliance was in place, the patient was able to carry on normal routine duties about the ward and also to engage in athletics. On several occasions, he went swimming without any discomfort and without disturbing the rubber band tension or the security of the appliance. Although there are few fractures of the mandible that demand external traction, those which do, I feel, can be as effectively treated with this appliance as with a plaster headcap, and with considerably more comfort to the patient.

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# Current Literature

INFLUENCE OF DIFFERENT FORMS OF MECHANICAL ARTIFICIAL RESPIRATION ON THE PULMONARY AND SYSTEMIC BLOOD PRESSURE. Perry P. Volpitto, Robert A. Woodbury and Benedict E. Abreu.

The authors report an improved technic for measuring the pulmonary and systemic blood pressure in animals with closed chest and premedicated with 3 to 5 mg. of morphine sulfate per kilogram. These pressures were recorded while respiration was maintained with the following resuscitators: anesthetic machine; Emerson respirator (iron lung); Kreiselman infant resuscitator, and "bellows" resuscitator; artificial pulmonary ventilation for operating room (Mautz model); lung ventilator, and Emerson resuscitator, J. H. model. All operative procedures were accomplished with the aid of local infiltration of 1 per cent procaine hydrochloride. Changes in pressure relationship between abdominal and thoracic cavities were recorded. Balloons fastened to leaden tubes were inserted in the abdominal and thoracic cavities. A differential manometer measured the net abdominal pressure. Sounds adapted to the size of the animal were attached to the manometers. Various degrees of reduced cardiac activity with severe depression or complete arrest of respiration were produced repeatedly. By producing several periods of severe hypoxia (oxygen want), it was possible to compare the effect of several methods in each animal. Cardiac arrest was produced by (1) complete occlusion of the airway, (2) use of helium with carbon dioxide absorption technic or (3) electrically induced ventricular fibrillation. Irrespective of the method of mechanical respiration employed, recovery of the animal was accomplished when respiratory arrest and slow weak cardiac contractions were produced by the use of helium. No significant change in pulmonary and systemic blood pressure was produced with any of the methods of resuscitation studied when cardiac and respiratory arrest occurred, either by helium or by electrically induced ventricular fibrillation. Any blood flow produced by the resuscitators did not reach the coronary and cerebral arteries, the blood being pushed toward the extremities and cutaneous areas.—*J.A.M.A.*, December 23, 1944.

COLOR MATCHING OF SKIN GRAFTS AND FLAPS WITH PERMANENT PIGMENT INJECTION. Gertrude Hance, James Barrett Brown, Louis F. Byars and Frank McDowell.

Under the encouragement, and with the suggestions, of Vilray Papin Blair, the authors, in twenty-seven instances, over a period of eight years, successfully employed pigment to match the color of free skin grafts to surrounding facial skin. The method has been employed eight times for matching skin flaps and in ten instances to simulate missing vermilion of the lip. The appearance of the repair area has been greatly improved and there have been no complications or bad results. The area is prepared with soap and water and alcohol, and the instruments are sterilized. If anesthesia is necessary, local block is most desirable. The dry colors are mixed on a glass slab and moistened with a



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physiologic solution of sodium chloride to the consistency of thick cream. The mixture for a facial graft should be a shade darker than the skin, starting with small amounts of red, yellow and white. Sometimes, an added drop of black gives the correct skin tone. The injection instrument, consisting of one or several fine needle points, is held like a pencil. The pigment is picked up on the points and the needle inserted obliquely in the skin. The electric vibrator of the professional tattooer, in the hands of the experienced, speeds the process. Excess pigment is constantly wiped from the skin so that the evenness of injection can be observed. A second treatment is often required to correct discrepancies in blending. Areas of hard scarring are not amenable to injection, areas of no pigmentation or soft white scars offering the best results.—*Surg., Gynec. & Obst.*, December 1944.

## Books Received

DENTAL TREATMENT OF MAXILLO-FACIAL INJURIES, WITH SUPPLEMENTARY MATERIAL ON CASES AND TECHNIQUES. By W. Kelsey Fry, L.D.S., Consulting Dental Surgeon to the Royal Air Force; P. Rae Shepard, L.D.S., Dental Surgeon, East Grinstead Maxillofacial Unit, and G. J. Parfitt, L.D.S., Dental Surgeon, East Grinstead Maxillofacial Unit. Cloth. 494 pages, illustrated. Price $6.50. Philadelphia: J. B. Lippincott Co., 1942. (Reviewed in the July 1944 issue, page 285.)

## Announcements

### AMERICAN BOARD OF ORTHODONTICS

The 1945 meeting of the American Board of Orthodontics will be held at the Broadmoor Hotel, Colorado Springs, May 17-20. Orthodontists who desire to be certificated by the board can obtain application blanks from the secretary, Bernard G. deVries, 705 Medical Arts Bldg., Minneapolis 2, Minn.

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### THE AMERICAN SOCIETY FOR THE ADVANCEMENT OF GENERAL ANESTHESIA IN DENTISTRY

The Spring Meeting of the American Society for the Advancement of General Anesthesia in Dentistry will be held Monday evening, March 26 at the Hotel McAlpin, New York City. The evening will be devoted to local and general anesthesia problems, and papers will be read by Nash C. Brennan, Shenandoah, Pa., and James T. Ivory, Binghamton, N. Y., to introduce a general discussion by the membership. George F. Seeman, president, of Nashville, Tenn., will preside.

M. HILLEL FELDMAN, *Executive Secretary,*
730 Fifth Ave.,
New York City.